Part 1

Estimates, Units, and Percentages

EUAP1.tex

Exercise 1 *How many inches are in a mile?* $\boxed{63360}$ *inches* $= 1$ *mile*

EUAP2.tex

Exercise 2 *How many yards are in a mile?* $\boxed{1,760}$ *yards*$= 1$ *mile*

EUAP3.tex

Exercise 3 *How many tablespoons are in a gallon?* $\boxed{256}$ *tablespoons* $= 1$ *gallon*

EUAP4.tex

Exercise 4 *How many cups of gasoline could fit into a 15 gallon tank?* $\boxed{240}$ *cups* $= 15$ *gallons*

EUAP5.tex

Exercise 5 *How many centimeters are in a kilometer?* $\boxed{100000}$ *cm* $= 1$ *km*

EUAP6.tex

Exercise 6 53 *dekaliters is how many milliliters?* $\boxed{530000}$ *mL* $= 53$ *daL*

EUAP7.tex

Exercise 7 *How many decigrams are in a hectogram?* $\boxed{1000}$ *dg*$= 1$ *hg*

EUAP8.tex

Exercise 8 *How many millimeters are in a decimeter?* $\boxed{100}$ *mm* $= 1$ *dm*

EUAP9.tex

Exercise 9 *You go to a restaurant and end up with a bill for* \$13.78. *How much is a* 20% *tip? How much is an* 18% *tip?* 20% = \$$\boxed{2.76}$ 18% = \$$\boxed{2.48}$

EUAP10.tex

Exercise 10 *You have a coupon for* 30% *off and want to buy an item that is* \$48.98.

How much money will you save? \$$\boxed{14.69}$

How much money will you pay? \$$\boxed{34.29}$

EUAP11.tex

Exercise 11 *A paper company advertises on their box of 20 reams of printer paper that it is "99.99% jam free." How many sheets of paper would you expect to lose, assuming when a paper jam happens, you "lose" that jammed piece of paper? (A ream of paper is 500 sheets).* $\boxed{1}$ *sheet(s) will jam*

EUAP12.tex

Exercise 12 *Suppose 485 people arrived at and event before 10 am. By the end of the event, we know there had been 1,673 total event attendees. What percent of the attendees arrived before 10 am?* $\boxed{29}$%

EUAP13.tex

Exercise 13 *After a garage sale, you see that 35% of what was sold was old records. If 14 records were sold, how many total items were sold at the sale?* $\boxed{40}$

EUAP14.tex

Exercise 14 *A student is conducting a survey for his/her statistics class. He/She decides to poll 20% of the 1200 full-time students on campus and 40% of the 4000 part-time students. What percent of the total student population did the student survey?* $\boxed{35.4}$%

EUAP15.tex

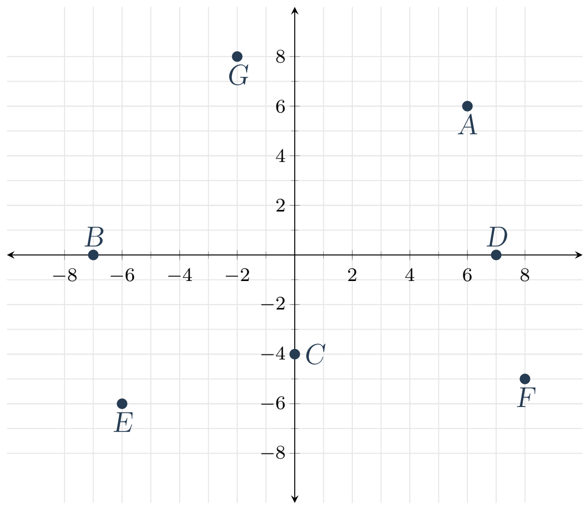
Exercise 15 *A shop owner raises the price of a* \$100 *pair of shoes by* 50%. *After a few weeks, because of falling sales, the owner reduces the price of the shoes by* 50%. *What is the new price of the shoes (after both percent changes have occurred)?* \$$\boxed{75}$

Part 2

Graphs and Relations

RaG1.tex

Exercise 16 *Give the Cartesian coordinates for each point on the graph:*



$$A = \left(\boxed{6}, \boxed{6}\right)$$

$$B = \left(\boxed{-7}, \boxed{0}\right)$$

$$C = \left(\boxed{0}, \boxed{-4}\right)$$

$$D = \left(\boxed{7}, \boxed{0}\right)$$

$$E = \left(\boxed{-6}, \boxed{-6}\right)$$

$$F = \left(\boxed{8}, \boxed{-5}\right)$$

$$G = \left(\boxed{2}, \boxed{8}\right)$$

RaG2.tex

Exercise 17 *For each given point, provide the quadrant in which it lies.*

(a) $(1, -2)$ *is in Quadrant* $\boxed{IV}$.

(b) $(72, 5)$ *is in Quadrant* $\boxed{I}$.

(c) $(-2.4, -2)$ *is in Quadrant* $\boxed{III}$.

(d) $(6, -0.8)$ *is in Quadrant* $\boxed{IV}$.

(e) $(-3, 2)$ *is in Quadrant* $\boxed{II}$.

(f) $(-\pi, \pi)$ *is in Quadrant* $\boxed{II}$.

`RaG3.tex`

Exercise 18 *Consider the relation with points of the form* (x, y), *where* x *represents a distance given in miles, and* y *represents the same distance in feet. For example,* $(1, 5280)$ *is in the relation.*

Fill in the following table with the correct values of the relation:

Distance in Miles	*Distance in Feet*
0	$\boxed{0}$
$\boxed{1}$	5280
3	$\boxed{15840}$
6	$\boxed{31680}$
$\boxed{10}$	52800

`RaG4.tex`

Exercise 19 *Consider the relation with points of the form* (x, y), *where* x *represents a volume given in liters, and* y *represents the same volume in milliliters. For example,* $(1, 1000)$ *is in the relation.*

Fill in the following table with the correct values of the relation:

Volume in Liters	*Volume in Milliliters*
0	$\boxed{0}$
$\boxed{1}$	1000
3	$\boxed{3000}$
16	$\boxed{16000}$
$\boxed{528}$	528000

RaG5.tex

Exercise 20 *Look at the following graph:*

Fill in the table below to give another representation of the relation given in the graph.

Age of Car	*Value*
0	$\boxed{25000}$
$\boxed{2}$	15750
4	$\boxed{11309}$
6	$\boxed{7500}$
$\boxed{8}$	4800

RaG6.tex

Exercise 21 *For each given point, say whether it is a member of the relation given by $x^2 - y^2 = 1$.*

(a) *Is $(1, -2)$ in the relation?*

Multiple Choice:

(i) *Yes*
(ii) *No* ✓

(b) *Is $(1, 0)$ in the relation?*

Multiple Choice:

(i) *Yes* ✓
(ii) *No*

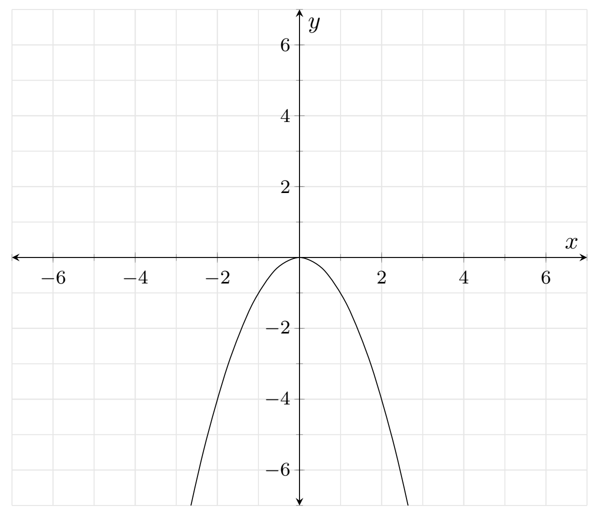
(c) *Is $(0, -1)$ in the relation?*

Multiple Choice:

(i) *Yes*
(ii) *No* ✓

RaG7.tex

Exercise 22 *Look at the following graph:*



Which type of famous function from the chapter is represented above?

Multiple Choice:

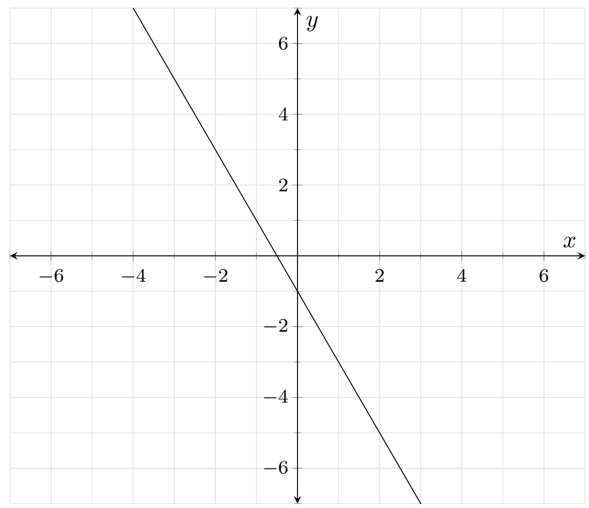
(a) *Parabola* ✓

(b) *Exponential*

(c) *Linear*

RaG8.tex

Exercise 23 *Look at the following graph:*



Which type of famous function from the chapter is represented above?

Multiple Choice:

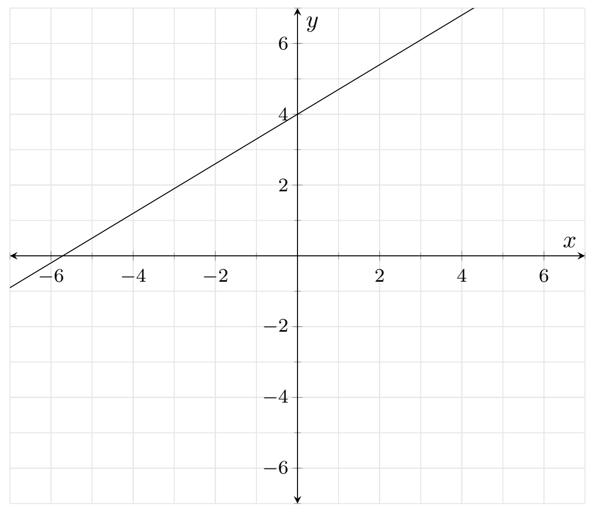
(a) *Parabola*

(b) *Exponential*

(c) *Linear* ✓

RaG9.tex

Exercise 24 *Look at the following graph:*



Which type of famous function from the chapter is represented above?

Multiple Choice:

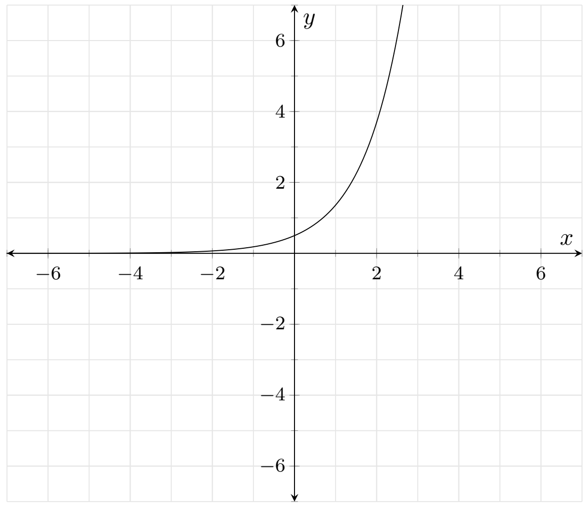
(a) *Parabola*

(b) *Exponential*

(c) *Linear* ✓

`RaG10.tex`

Exercise 25 *Look at the following graph:*



Which type of famous function from the chapter is represented above?

Multiple Choice:

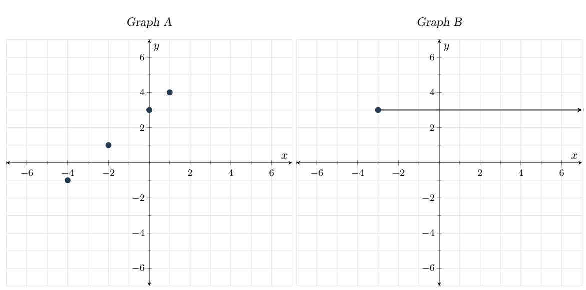
(a) *Parabola*

(b) *Exponential* ✓

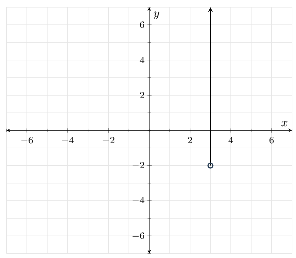
(c) *Linear*

`RaG11.tex`

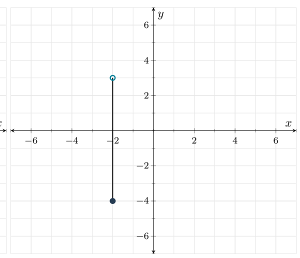
Exercise 26 *Look at the following graphs and match each to a description of a relation below:*



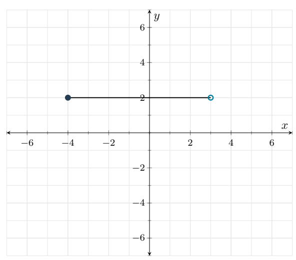
Graph C



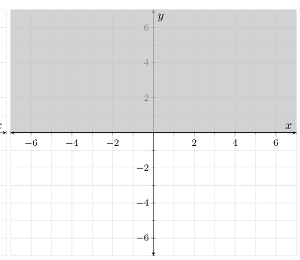
Graph D



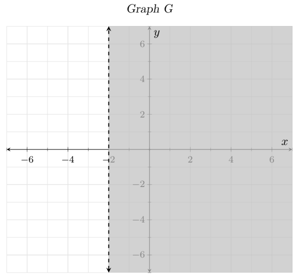
Graph E



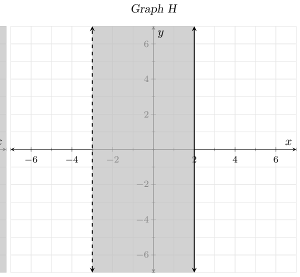
Graph F



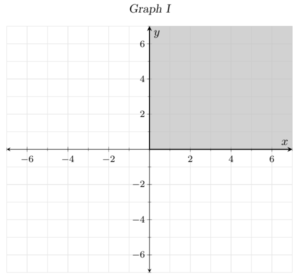
Graph G



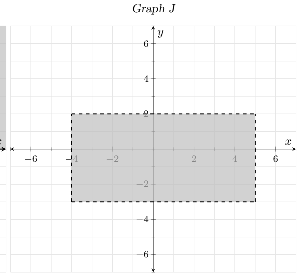
Graph H



Graph I



Graph J



(a) *The points* (x, y) *with* $-3 < x \leq 2$.

Multiple Choice:

(i) *A*

(ii) *B*

(iii) C
(iv) D
(v) E
(vi) F
(vii) G
(viii) H ✓
(ix) I
(x) J

(b) *The points (x, y) with $x = -2$ and $-4 \leq y < 3$.*

Multiple Choice:

(i) A
(ii) B
(iii) C
(iv) D ✓
(v) E
(vi) F
(vii) G
(viii) H
(ix) I
(x) J

(c) *The points (x, y) with $x > -2$.*

Multiple Choice:

(i) A
(ii) B
(iii) C
(iv) D
(v) E
(vi) F
(vii) G ✓
(viii) H
(ix) I
(x) J

(d) *The points* (x, y) *with* $x \geq 0$ *and* $y \geq 0$.

Multiple Choice:

(i) A
(ii) B
(iii) C
(iv) D
(v) E
(vi) F
(vii) G
(viii) H
(ix) I ✓
(x) J

(e) *The points* (x, y) *with* $-4 < x < 5$ *and* $-3 < y < 2$.

Multiple Choice:

(i) A
(ii) B
(iii) C
(iv) D
(v) E
(vi) F
(vii) G
(viii) H
(ix) I
(x) J ✓

(f) *The points* (x, y) *with* $-4 \leq x < 3$ *and* $y = 2$.

Multiple Choice:

(i) A
(ii) B
(iii) C
(iv) D
(v) E ✓

(vi) F

(vii) G

(viii) H

(ix) I

(x) J

(g) *The points* (x, y) *with* $-3 \leq x$ *and* $y = 3$.

Multiple Choice:

(i) A

(ii) B ✓

(iii) C

(iv) D

(v) E

(vi) F

(vii) G

(viii) H

(ix) I

(x) J

(h) *The points* (x, y) *with* $y \geq 0$.

Multiple Choice:

(i) A

(ii) B

(iii) C

(iv) D

(v) E

(vi) F ✓

(vii) G

(viii) H

(ix) I

(x) J

(i) *The points* $(-4, -1)$, $(-2, 1)$, $(0, 3)$, *and* $(1, 4)$.

Multiple Choice:

(i) A ✓
(ii) B
(iii) C
(iv) D
(v) E
(vi) F
(vii) G
(viii) H
(ix) I
(x) J

(j) *The points* (x, y) *with* $x = 3$ *and* $y > -2$.

Multiple Choice:

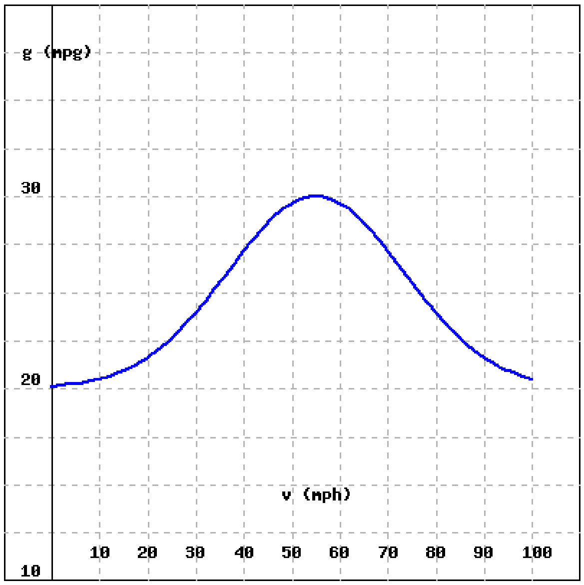
(i) A
(ii) B
(iii) C ✓
(iv) D
(v) E
(vi) F
(vii) G
(viii) H
(ix) I
(x) J

Part 3

Changing in Tandem

CiT1.tex

Exercise 27 *The graph below shows the fuel consumption (in miles per gallon, mpg) of a car driving at various speeds (in miles per hour, mph).*



(a) *How much gas is used on a 400 mile trip at 80 mph?*
amount of gas = $\boxed{400/24}$ *gallons*

Hint: *When the car is going 80 mph, it appears from the graph that the fuel consumption is approximately 24 mpg.*

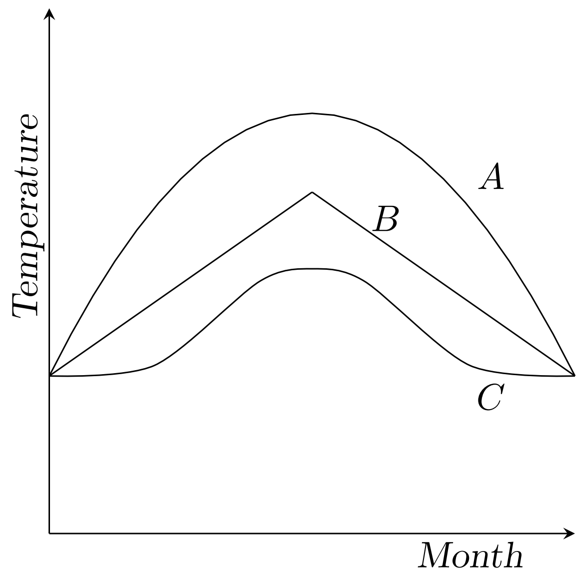
(b) *How much gas is saved by traveling 60 mph instead of 70 mph on a 600 mile trip?*
saved gas = $\boxed{600/30 - 600/27}$ *gallons*

(c) *According to this graph, what is the most fuel efficient speed to travel?*
most fuel efficient speed=$\boxed{55}$ *mph*

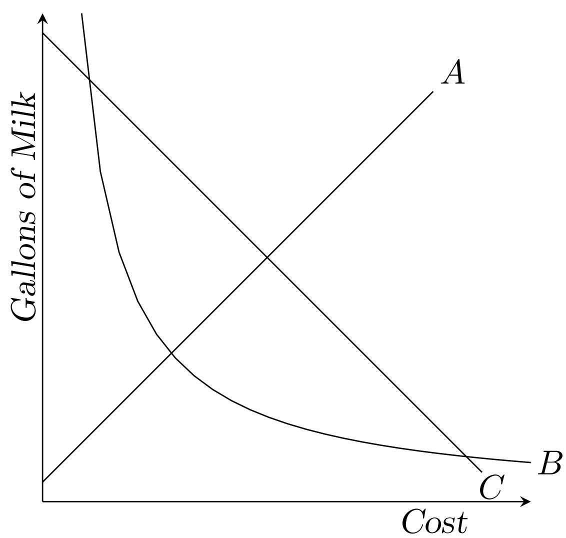
CiT2.tex

Exercise 28 *For each of the situations below, pick the graph that most reasonably reflects the situation and the variables involved.*

(a) *The daily high temperature recorded in Chicago from January to December:* $\boxed{C}$

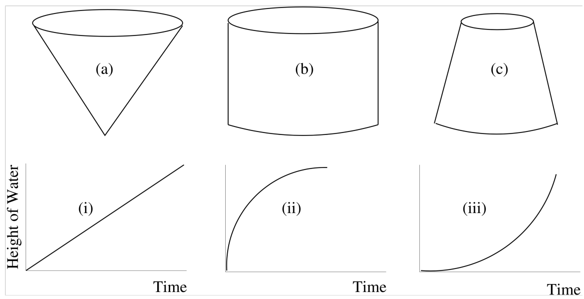


(b) *The number of gallons of milk you can buy with \$5 as the cost per gallon of milk increases:* $\boxed{B}$



CiT3.tex

Exercise 29 *Water is poured at a constant rate into the three containers shown below. Which graph corresponds to which container?*



Which graph corresponds to container (a)?

Multiple Choice:

(a) *(i)*

(b) *(ii)* ✓

(c) *(iii)*

Which graph corresponds to container (b)?

Multiple Choice:

(a) *(i)* ✓

(b) *(ii)*

(c) *(iii)*

Which graph corresponds to container (c)?

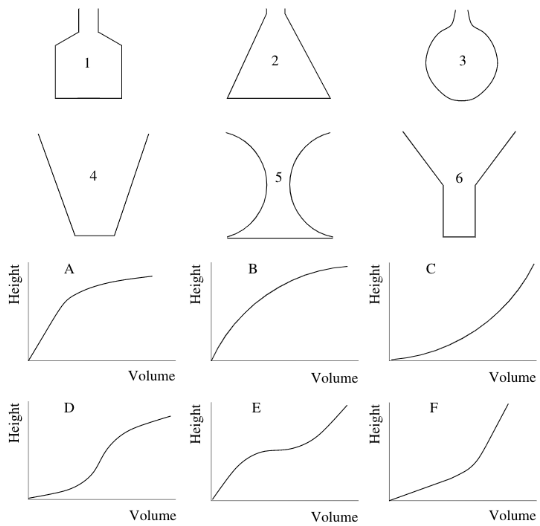
Multiple Choice:

(a) *(i)*

(b) *(ii)*

(c) *(iii)* ✓

Exercise 30 *Water is poured at a constant rate into the six containers shown below. Which graph corresponds to which container?*



Which graph corresponds to container 1?

Multiple Choice:

(a) *A*

(b) *B*

(c) *C*

(d) *D*

(e) *E*

(f) *F* ✓

Which graph corresponds to container 2?

Multiple Choice:

(a) *A*

(b) *B*

(c) C ✓

(d) D

(e) E

(f) F

Which graph corresponds to container 3?

Multiple Choice:

(a) A

(b) B

(c) C

(d) D

(e) E ✓

(f) F

Which graph corresponds to container 4?

Multiple Choice:

(a) A

(b) B ✓

(c) C

(d) D

(e) E

(f) F

Which graph corresponds to container 5?

Multiple Choice:

(a) A

(b) B

(c) C

(d) D ✓

(e) E

(f) F

Which graph corresponds to container 6?

Multiple Choice:

(a) A ✓

(b) B

(c) C

(d) D

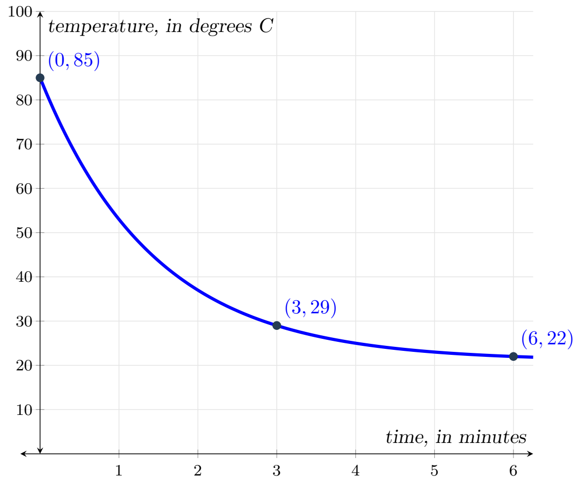
(e) E

(f) F

Part 4

Linear Equations

Exercise 31 *The graph below shows the temperature T, in degrees Celsius, of an object at time t, in minutes.*



(a) *Based on the graph above, is this object heating up or cooling down?*

Multiple Choice:

(i) *Heating Up*

(ii) *Cooling Down* ✓

(b) *What is the rate of change in this data between the point corresponding to $t = 0$ minutes, and the point corresponding to $t = 3$ minutes?* $\boxed{-56/3}$ *degrees Celsius/minute.*

Hint: *Recall that the rate of change between two data points is given by* $\frac{\Delta T}{\Delta t}$.

(c) *What is the rate of change in this data between the point corresponding to $t = 3$ minutes, and the point corresponding to $t = 6$ minutes?* $\boxed{-7/3}$ *degrees Celsius/minute.*

(d) *Based on the your answers above, does this data always have the same rate of change?*

Multiple Choice:

(i) *Yes*

(ii) *No* ✓

LE2.tex

Exercise 32 *A table of data is given below.*

x	y
0	2
1	5
2	8
5	

(a) *The rate of change from the top row to the second row is:* $\boxed{3}$.

(b) *The rate of change from the top row to the second row is:* $\boxed{3}$.

(c) *If this rate of change is maintained, whenever the x-value of a data point increases by* 1*, the y-value of the data point must increase by* $\boxed{3}$.

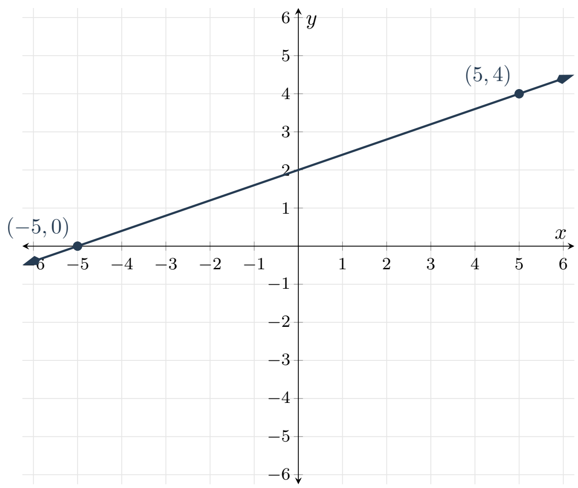
(d) *If this rate of change is maintained, whenever the x-value of a data point increases by* 3*, the y-value of the data point must increase by* $\boxed{9}$.

(e) *If this rate of change is maintained, the x-value* 5 *corresponds to the y-value* $\boxed{17}$.

(f) *An equation that describes the pattern in the table is* $y = \boxed{3x+2}$.

LE3.tex

Exercise 33



(a) *The slope of this line is*

Multiple Choice:

(i) *positive because y is increasing* ✓
(ii) *positive because y is decreasing*
(iii) *negative because y is increasing*
(iv) *negative because y is decreasing*

(b) *The slope of this line is* $m = \boxed{2/5}$.

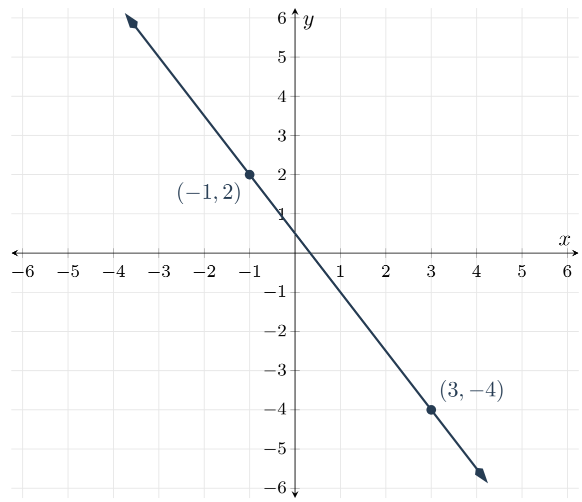
Hint: *Recall that the slope of the line is the rate of change between any two data points on the line,* $m = \dfrac{\Delta y}{\Delta x}$.

(c) *The y-value of the point corresponding to $x = 9$ is* $\boxed{28/5}$.

Hint: *How much y increases if x increases by 1? How much does y increase if x increases by 4?*

`LE4.tex`

Exercise 34



(a) *The slope of this line is*

Multiple Choice:

(i) *positive because y is increasing*
(ii) *positive because y is decreasing*
(iii) *negative because y is increasing*
(iv) *negative because y is decreasing* ✓

(b) *The slope of this line is* $m = \boxed{-3/2}$.

Hint: *Recall that the slope of the line is the rate of change between any two data points on the line,* $m = \dfrac{\Delta y}{\Delta x}$.

(c) *The y-value of the point corresponding to $x = 0$ is* $b = \boxed{1/2}$.

(d) *The point-intercept form of the equation of this line is* $y = \boxed{-3/2}\, x + \boxed{1/2}$.

(e) *The point-slope form of the equation of this line is* $y - 2 = \boxed{-3/2}\left(x - \boxed{-1}\right)$.

(f) *The equation of this line in standard form* $\boxed{3}\, x + \boxed{2}\, y = 1$.

`LE5.tex`

Exercise 35 *A particular car is known to have a fuel efficiency of 32 miles/-gallon (mpg).*

(a) *If this car is driven 32 miles, it uses* $\boxed{1}$ *gallons of fuel.*

(b) *If this car is driven 96 miles, it uses* $\boxed{3}$ *gallons of fuel.*

(c) *Call x the number of miles driven and y the gallons of fuel used. Then x and y have a linear relationship.*

(i) *The slope of this linear relationship is* $\boxed{1/32}$ *gallons/mile.*

(ii) *The equation of this line in slope-intercept form is given by* $y = \boxed{(1/32) * x + 0}$.

LE6.tex

Exercise 36 *Vertical Lines*

Vertical lines do not have a slope. They consist of all points with the same x-coordinate. For example, the linear relationship with data given in this table consists of points with x-coordinate equal to 5.

x	y
5	-1
5	0
5	1
5	2

Since this line does not have a slope, we can not express its equation in either point-slope or slope-intercept forms. Instead, a vertical line has an equation of the form $x = C$, where C is the common x-coordinate between all the points, meaning that the line given in the table above has equation $x = 5$.

(a) *The line given by the following table of data:*

x	y
2	-3
2	1
2	1
2	3
2	5

has equation given by $x = \boxed{2}$.

(b) *The line given by the following table of data:*

x	y
$-3/4$	-8
$-3/4$	-7
$-3/4$	-6
$-3/4$	-5

has equation given by $x = \boxed{-\frac{3}{4}}$.

LE7.tex

Exercise 37 *Parallel lines*

Remember that two lines in the plane are parallel if they never intersect. This means that they are each traveling in the same direction. Any two vertical lines are parallel. Any two horizontal lines are parallel. Two non-vertical lines are parallel if and only if they have the same slope.

(a) *Suppose a line has equation $y = 3x + 4$. An equation of the line parallel to this line, with y-intercept at $(0, -2)$ is given in slope-intercept form by $y = \boxed{3}x + \boxed{-2}$.*

(b) *Suppose a line has equation $x = -2$. An equation of the line parallel to this, which passes through the point $(4, 2)$ has equation $x = \boxed{4}$.*

(c) *Suppose a line has equation $5x+2y = -4$. An equation of the line parallel to this, which passes through the point $(2, -3)$ is given in point-slope form by $y - \boxed{-3} = \boxed{-5/2}\left(x - \boxed{2}\right)$.*

LE8.tex

Exercise 38 *Perpendicular lines*

Remember that two lines in the plane are perpendicular if the intersect at a right-angle, of 90 °. Any vertical line is perpendicular to any horizontal line. Two non-vertical lines are perpendicular if and only if their slopes multiply to -1. That is, if the slope of the first line m_1 and the slope of the second line m_2 have $m_1 m_2 = -1$.

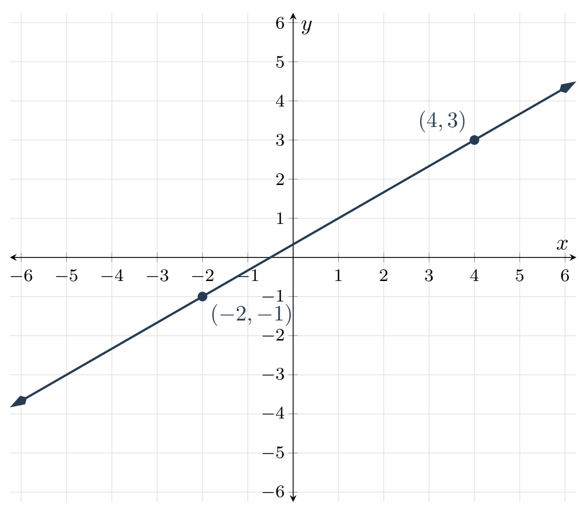
(a) *Suppose a line has equation $y = 3x + 4$. An equation of the line perpendicular to this line, with y-intercept at $(0, -2)$ is given in slope-intercept form by* $y = \boxed{-1/3}\,x + \boxed{-2}$.

(b) *Suppose a line has equation $x = -2$. An equation of the line perpendicular to this, which passes through the point $(4, 2)$ has equation* $y = \boxed{2}$.

(c) *Suppose a line has equation $5x + 2y = -4$. An equation of the line perpendicular to this, which passes through the point $(2, -3)$ is given in point-slope form by* $y - \boxed{-3} = \boxed{2/5}\left(x - \boxed{2}\right)$.

LE9.tex

Exercise 39 *The graph of a line is given below.*



(a) *The line parallel to this graphed line, which passes through the point $(3, 1)$ has equation in point-slope form given by* $y - \boxed{1} = \boxed{2/3}\left(x - \boxed{3}\right)$.

(b) *The line perpendicular to this graphed line, which passes through the point $(-2, 3)$ has equation in slope-intercept form given by* $y = \boxed{-3/2}\,x + \boxed{0}$.

Part 5

Linear Modeling

LM1.tex

Exercise 40 *A landscaping company charges \$45 per cubic yard of mulch plus a delivery charge of \$20.*

(a) *A linear function which computes the total cost C (in dollars) to deliver x cubic yards of mulch is given by* $y = \boxed{45x + 20}$.

(b) *According to the linear function above, 20 cubic yards of mulch costs* $\$\boxed{920}$.

(c) *According to the linear function above, \$560 will buy you* $\boxed{12}$ *cubic yards of mulch.*

LM2.tex

Exercise 41 *Water freezes at* 0° *Celsius and* 32° *Fahrenheit and it boils at* $100^\circ C$ *and* $212^\circ F$.

Write your answers as improper fractions if necessary.

(a) *A linear function F that expresses temperature in the Fahrenheit scale in terms of degrees Celsius (which we represent by the variable x) is* $F(x) = \boxed{(9/5)x + 32}$.

(b) *Using the above function,* $20^\circ C$ *is* $\boxed{68}^\circ$ *Fahrenheit.*

(c) *A linear function C that expresses temperature in the Celsius scale in terms of degrees Fahrenheit (which we represent by the variable x) is* $C(x) = \boxed{(5/9)x - 160/9}$.

(d) *Using the above function,* $110^\circ F$ *is* $\boxed{130/3}^\circ$ *Celsius.*

(e) *The temperature x at which $F(x) = C(x)$ is* $\boxed{-40}^\circ$.

LM3.tex

Exercise 42 *Your friend buys a new car, and as soon as they drive it off the lot, it begins to depreciate in value. After 2 years, the car is worth* $\$16,000$ *and after 4 years, the car is worth* $\$12,000$. *Assume that the car's value drops linearly.*

(a) *A linear function V that expresses the value of the car in terms of the number of years x since it was purchased is* $V(x) = \boxed{-2000x + 20000}$.

(b) *The y-intercept of the function V is* $(\boxed{0}, \boxed{20000})$.

(c) *The y value of the y-intercept represents*

Multiple Choice:

(i) *the starting value of the car.* ✓

(ii) *the time at which the car's value is 0.*

(iii) *the average value of the car over its lifespan.*

(d) *The x-intercept of the function V is* $(\boxed{40}, \boxed{0})$.

(e) *The x value of the x-intercept represents*

Multiple Choice:

(i) *the starting value of the car.*

(ii) *the time at which the car's value is 0.* ✓

(iii) *the average value of the car over its lifespan.*

`LM4.tex`

Exercise 43 *You and your friend decide to have a bike race. Your speed is 16 kilometers per hour, and your friend's is 20 kilometers per hour. Your friend is faster than you are, so they give you a head start of 2 kilometers.*

Let $f(x)$ be a linear function expressing the distance (in kilometers) you travel, and $g(x)$ be a linear function expressing the distance (in kilometers) your friend travels.

(a) *One of the following graphs represents $f(x)$ and the other represents $g(x)$. The graph representing $f(x)$ is*

Multiple Choice:

(i) *Graph A.*

(ii) *Graph B.* ✓

(b) *A linear equation for the distance you travel is* $f(x) = \boxed{16x + 2}$.

(c) *A linear equation for the distance your friend travels is* $g(x) = \boxed{20x}$.

(d) *If the race is 5 kilometers long, who will win?*

Multiple Choice:

(i) *You* ✓
(ii) *Your friend*
(iii) *It will be a tie*

(e) *If the race is 10 kilometers long, who will win?*

Multiple Choice:

(i) *You*
(ii) *Your friend*
(iii) *It will be a tie* ✓

(f) *If the race is 20 kilometers long, who will win?*

Multiple Choice:

(i) *You*
(ii) *Your friend* ✓
(iii) *It will be a tie*

`LM5.tex`

Exercise 44 *A salesperson is paid \$200 per week plus 5% commission on her weekly sales of x dollars.*

(a) *A linear function that represents her total weekly pay, W (in dollars) in terms of x is $W(x) = \boxed{.05x + 200}$.*

(b) *In order for her to earn \$475 for the week, her weekly sales must be \$$\boxed{5500}$.*

Part 6

Exponential Modeling

EM1.tex

Exercise 45 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108}x^{\boxed{4}}y^{\boxed{9}}$.

EM2.tex

Exercise 46 *Simplify and give your answer as a fraction:*

$$\left(\frac{r}{s^2}\right)^3\left(\frac{s^5}{r^6}\right)^2 = \frac{\boxed{s^4}}{\boxed{r^9}}.$$

EM3.tex

Exercise 47 *Simplify:* $(ab)^2(a^2b^{-1})^3(a^2b^{-1})^{-1} = a^{\boxed{6}}b^{\boxed{0}}$.

EM4.tex

Exercise 48 *Simplify:* $\dfrac{t^{r+s} - t^r}{t^r} = t^{\boxed{s}} - t^{\boxed{0}}$.

EM5.tex

Exercise 49 *Simplify and give your answer as a fraction:*

$$\left(\frac{p^7}{q^8}\right)^2\left(\frac{q^2}{p^{-3}}\right)^5 = \frac{\boxed{p^{29}}}{\boxed{q^6}}.$$

EM6.tex

Exercise 50 *Simplify and express your answer without using fractions (use negative exponents if needed):*

$$\left(\frac{m^2}{n^6}\right)^2\left(\frac{n^4}{m^3}\right)^5 = m^{\boxed{-11}}n^{\boxed{8}}$$

EM7.tex

Exercise 51 *Simplify:* $(6r^4)^3 \left(\frac{y^3}{2}\right)^3 = \boxed{27} r^{\boxed{12}} y^{\boxed{9}}$

EM8.tex

Exercise 52

(a) *Simplify and factor:* $\frac{x^{r+4} - x^{r+2}}{x^{r+1}} = x^{\boxed{3}} - x^{\boxed{1}}$.

(b) *What is the correct factorization of the result found in the previous item?*

Multiple Choice:

(i) $x^2(x-1)$

(ii) $x(x-1)(x-2)$

(iii) $x(x-1)(x+1)$ ✓

(iv) $(x-1)^3$

EM9.tex

Exercise 53 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108} x^{\boxed{4}} y^{\boxed{9}}$

EM10.tex

Exercise 54 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108} x^{\boxed{4}} y^{\boxed{9}}$

EM11.tex

Exercise 55 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108} x^{\boxed{4}} y^{\boxed{9}}$

EM12.tex

Exercise 56 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108}x^{\boxed{4}}y^{\boxed{9}}$

EM13.tex

Exercise 57 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108}x^{\boxed{4}}y^{\boxed{9}}$

EM14.tex

Exercise 58 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108}x^{\boxed{4}}y^{\boxed{9}}$

EM15.tex

Exercise 59 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108}x^{\boxed{4}}y^{\boxed{9}}$

EM16.tex

Exercise 60 *Simplify:* $(2x^2)^2(3y^3)^3 = \boxed{108}x^{\boxed{4}}y^{\boxed{9}}$

Part 7

What is a Function?

WiaF1.tex

Exercise 61 *A national park records data regarding the total fox population F over a 12 month period, where $t = 0$ means January 1, $t = 1$ means February 1, and so on. Below is the table of values they recorded:*

t, month	F, foxes
0	150
1	143
2	125
3	100
4	75
5	57
6	50
7	57
8	75
9	100
10	125
11	143

Is t a function of F?

Multiple Choice:

(a) *Yes*

(b) *No* ✓

Is F a function of t?

Multiple Choice:

(a) *Yes* ✓

(b) *No*

Exercise 61.1 *(b) Let $g(t) = F$ denote the fox population in month t. How many solution(s) are there to the equation $g(t) = 125$?.*

Multiple Choice:

(a) *0*

Acknowledgements: Active Prelude to Calculus (https://activecalculus.org/prelude)

(b) *1*

(c) *2* ✓

(d) *3*

(e) *4*

(f) *5*

Exercise 61.1.1 *What are the solutions to $g(t) = 125$?*

The smaller solution is $\boxed{2}$ *and the larger solution is* $\boxed{10}$.

Part 8

Function Properties

FP1.tex

Exercise 62 *Let f be a function defined as follows.*

$$f(x) = \begin{cases} x^2, & x < 0 \\ x, & x \geq 0 \end{cases}$$

Exercise 62.1 (a) *Compute $f(1)$.*

$f(1) = \boxed{1}$

(b) *Compute $f(-1)$.*

$f(-1) = \boxed{1}$

(c) *The calculations in parts (a) and (b) above show that f is*

Multiple Choice:

(i) *neither even nor odd.*
(ii) *even but not odd.*
(iii) *odd but not even.*
(iv) *both even and odd.*
(v) *not odd, but f may not be even.* ✓
(vi) *not even, but f may not be odd.*

Exercise 62.2 (a) *Compute $f(2)$.*

$f(2) = \boxed{2}$

(b) *Compute $f(-2)$.*

$f(-2) = \boxed{4}$

(c) *The calculations in parts (a) and (b) above show that f is*

Multiple Choice:

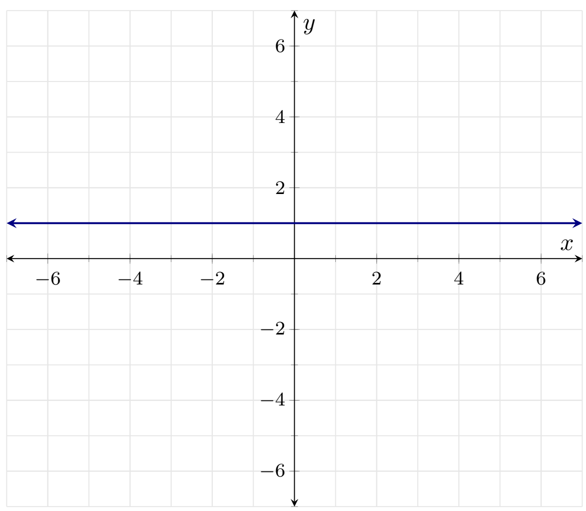
(i) *neither even nor odd.* ✓
(ii) *even, but not odd.*
(iii) *odd, but not even.*
(iv) *both even and odd.*
(v) *The calculations do not say anything about whether f is even or odd.*

FP2.tex

Exercise 63 *In each part, you will be shown a graph of a function. Assume that all the important behavior of the functions is shown on the given graphs.*

(a) *The function corresponding to Graph A below is*

Graph A



Multiple Choice:

(i) *neither even nor odd.*

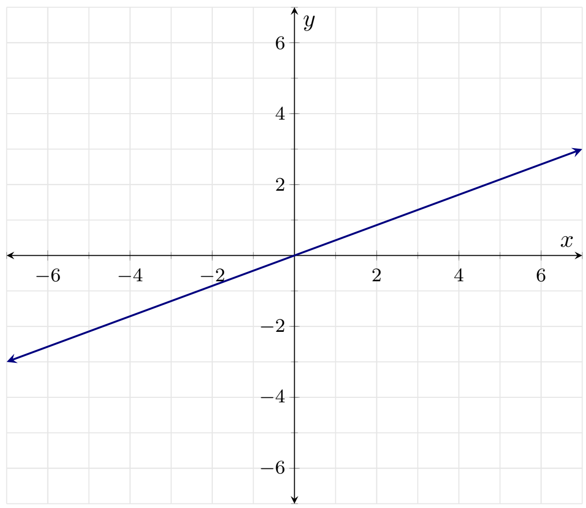
(ii) *even, but not odd.* ✓

(iii) *odd, but not even.*

(iv) *both even and odd.*

(b) *The function corresponding to Graph B below is*

Graph B



Multiple Choice:

(i) *neither even nor odd.*

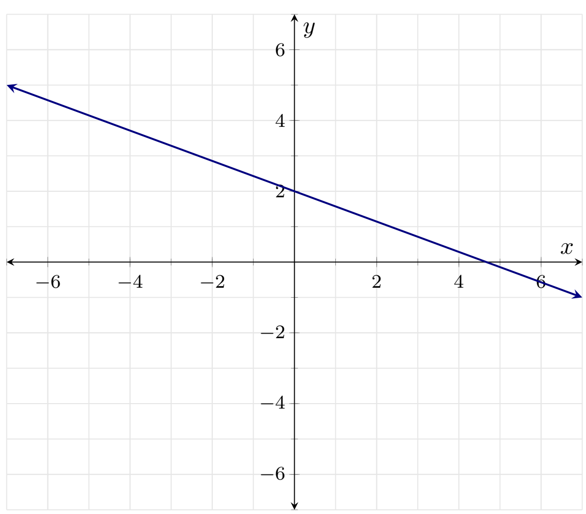
(ii) *even, but not odd.*

(iii) *odd, but not even.* ✓

(iv) *both even and odd.*

(c) *The function corresponding to Graph C below is*

Graph C



Multiple Choice:

(i) *neither even nor odd.* ✓

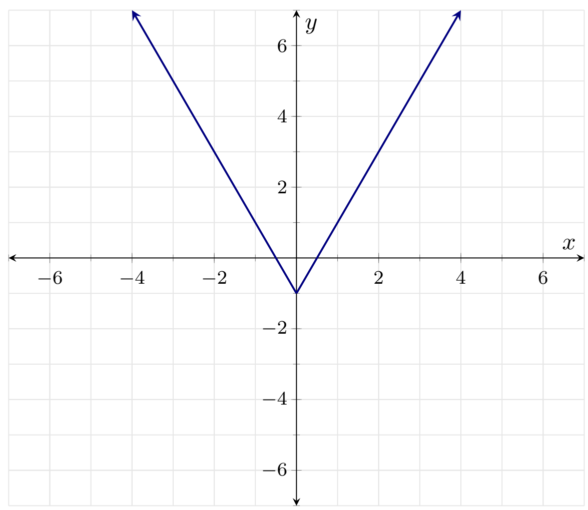
(ii) *even, but not odd.*

(iii) *odd, but not even.*

(iv) *both even and odd.*

(d) *The function corresponding to Graph D below is*

Graph D



Multiple Choice:

(i) *neither even nor odd.*

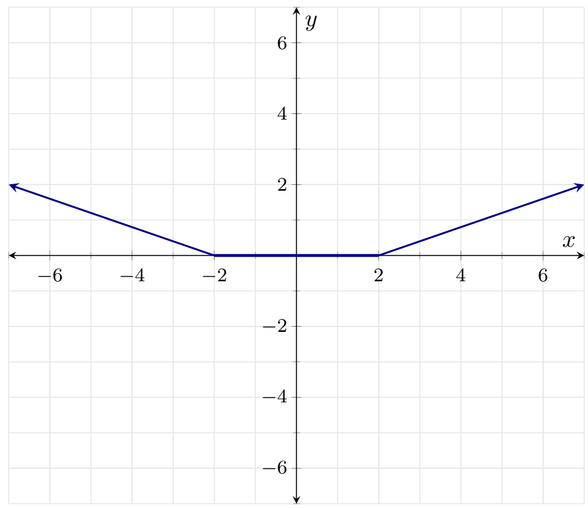
(ii) *even, but not odd.* ✓

(iii) *odd, but not even.*

(iv) *both even and odd.*

(e) *The function corresponding to Graph E below is*

Graph E



Multiple Choice:

(i) *neither even nor odd.*

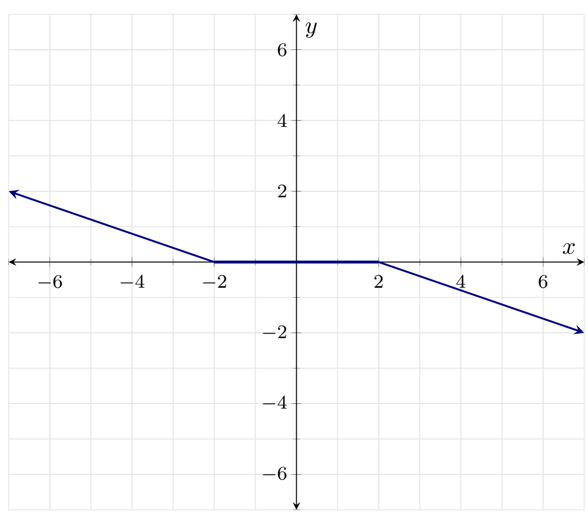
(ii) *even, but not odd.* ✓

(iii) *odd, but not even.*

(iv) *both even and odd.*

(f) *The function corresponding to Graph F below is*

Graph F



Multiple Choice:

(i) *neither even nor odd.*

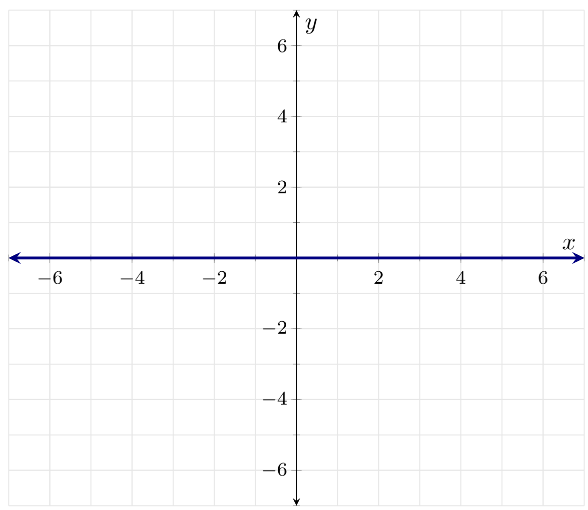
(ii) *even, but not odd.*

(iii) *odd, but not even.* ✓

(iv) *both even and odd.*

(g) *The function corresponding to Graph G below is*

Graph G



Multiple Choice:

(i) *neither even nor odd.*

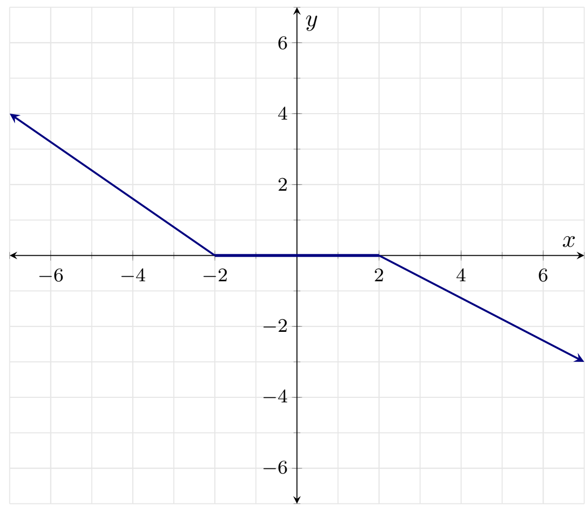
(ii) *even, but not odd.*

(iii) *odd, but not even.*

(iv) *both even and odd.* ✓

(h) *The function corresponding to Graph H below is*

Graph H



Multiple Choice:

(i) *neither even nor odd.* ✓
(ii) *even, but not odd.*
(iii) *odd, but not even.*
(iv) *both even and odd.*

`FP3.tex`

Exercise 64 (a) *The function f defined by $f(x) = 12x$ is*

Multiple Choice:

(i) *even.*
(ii) *odd.* ✓
(iii) *neither even nor odd.*
(iv) *both even and odd.*

(b) *The function f defined by $f(x) = 12x + 2$ is*

Multiple Choice:

(i) *even.*
(ii) *odd.*

(iii) *neither even nor odd.* ✓
(iv) *both even and odd.*

(c) *The function f defined by $f(x) = 12$ is*

Multiple Choice:

(i) *even.* ✓
(ii) *odd.*
(iii) *neither even nor odd.*
(iv) *both even and odd.*

(d) *The function f defined by $f(x) = 5x^2 - 4$ is*

Multiple Choice:

(i) *even.* ✓
(ii) *odd.*
(iii) *neither even nor odd.*
(iv) *both even and odd.*

(e) *The function f defined by $f(x) = 3x^3 - 5x$ is*

Multiple Choice:

(i) *even.*
(ii) *odd.* ✓
(iii) *neither even nor odd.*
(iv) *both even and odd.*

(f) *The function f defined by $f(x) = 0$ is*

Multiple Choice:

(i) *even.*
(ii) *odd.*
(iii) *neither even nor odd.*
(iv) *both even and odd.* ✓

`FP4.tex`

Exercise 65 *The set of integers is the set* $\{\ldots,-3,-2,-1,0,1,2,3,\ldots\}$ *consisting of all counting numbers, their negatives, and zero.*

The floor *of* x*, denoted* $\lfloor x \rfloor$ *is defined to be the largest integer* k *with* $k \leq x$*. For example,* $\lfloor 5.2 \rfloor = 5$*,* $\lfloor -99.9 \rfloor = -100$ *and* $\lfloor -3 \rfloor = -3$*.*

(a) *The function* f *defined by* $f(x) = \lfloor x \rfloor$ *is*

Multiple Choice:

(i) *odd.*
(ii) *even.*
(iii) *neither odd nor even.* ✓
(iv) *both odd and even.*

(b) *The function* f *defined by* $f(x) = \lfloor x \rfloor$ *is*

Multiple Choice:

(i) *one-to-one.*
(ii) *not one-to-one.* ✓

FP5.tex

Exercise 66 *Recall from the chapter that sine and cosine are periodic functions with period* 2π*. This means that for all inputs* x*,* $\sin(x+2\pi) = \sin(x)$ *and* $\cos(x+2\pi) = \cos(x)$*.*

(a) *Consider the function* f *defined by* $f(x) = 2\sin(x)$*.* f *is*

Multiple Choice:

(i) *not periodic.*
(ii) *periodic with period* π*.*
(iii) *periodic with period* 2π*.* ✓
(iv) *periodic with period* 3π*.*
(v) *periodic with period* 4π*.*

(b) *Consider the function* g *defined by* $g(x) = \cos(x+5)$*.* g *is*

Multiple Choice:

(i) *not periodic.*

(ii) *periodic with period* π.

(iii) *periodic with period* 2π. ✓

(iv) *periodic with period* 3π.

(v) *periodic with period* 4π.

(c) *Consider the function* h *defined by* $h(x) = \sin(x) + 2\cos(x)$. h *is*

Multiple Choice:

(i) *not periodic.*

(ii) *periodic with period* π.

(iii) *periodic with period* 2π. ✓

(iv) *periodic with period* 3π.

(v) *periodic with period* 4π.

`FP6.tex`

Exercise 67 *Recall from the chapter that sine is an odd function and cosine is an even function. This means that for all inputs* x, $\sin(-x) = -\sin(x)$ *and* $\cos(-x) = \cos(x)$. *Additionally, sine is not even, and cosine is not odd.*

(a) *Consider the function* f *defined by* $f(x) = 7.2\sin(x)$. f *is*

Multiple Choice:

(i) *even.*

(ii) *odd.* ✓

(iii) *neither even nor odd.*

(b) *Consider the function* g *defined by* $g(x) = \cos(x) + 308$. g *is*

Multiple Choice:

(i) *even.* ✓

(ii) *odd.*

(iii) *neither even nor odd.*

(c) *Consider the function* h *defined by* $h(x) = \sin(x) + \cos(x)$. *For reference, here is a graph of* h *on Desmos:*

Desmos link: `https://www.desmos.com/calculator/t0r1zihobf`

h is

Multiple Choice:

(i) *even.*
(ii) *odd.*
(iii) *neither even nor odd.* ✓

FP7.tex

Exercise 68 *Recall from the chapter that sine and cosine are periodic functions with period 2π. This means that for all inputs x, $\sin(x+2\pi) = \sin(x)$ and $\cos(x+2\pi) = \cos(x)$.*

Many functions that can be built out of sin *and* cos *are also periodic. In this exercise, we'll use Desmos to explore how the period can change.*

(a) *Consider the function f defined by $f(x) = \sin(3x)$. For reference, here is a graph of f on Desmos:*

Desmos link: `https://www.desmos.com/calculator/uc3meehtpv`

The period of f is

Multiple Choice:

(i) π.
(ii) 2π.
(iii) 3π.
(iv) 6π.
(v) $\frac{\pi}{2}$.
(vi) $\frac{2\pi}{3}$. ✓

(b) *Consider the function g defined by $g(x) = \cos\left(\frac{x}{3}\right)$. For reference, here is a graph of g on Desmos:*

Desmos link: `https://www.desmos.com/calculator/364oqkoauu`

The period of g is

Multiple Choice:

(i) π.

(ii) 2π.

(iii) 3π.

(iv) 6π. ✓

(v) $\frac{\pi}{2}$.

(vi) $\frac{2\pi}{3}$.

(c) *Consider the function h defined by $h(x) = \sin(2x - \pi)$. For reference, here is a graph of h on Desmos:*

Desmos link: `https://www.desmos.com/calculator/wha8ccbi93`

The period of h is

Multiple Choice:

(i) π. ✓

(ii) 2π.

(iii) 3π.

(iv) 6π.

(v) $\frac{\pi}{2}$.

(vi) $\frac{2\pi}{3}$.

`FP8.tex`

Exercise 69 *In each part, an invertible function f will be defined. For each function, find a formula for f^{-1} where f is defined.*

(a) $f(x) = 2x - 6$

$f^{-1}(x) = \boxed{\frac{6+x}{2}}$

(b) $f(x) = 29 - x$

$f^{-1}(x) = \boxed{29 - x}$

(c) $f(x) = \frac{x-3}{2} + 3$

$f^{-1}(x) = \boxed{2x - 3}$

(d) $f(x) = \sqrt{5x-1} + 3$

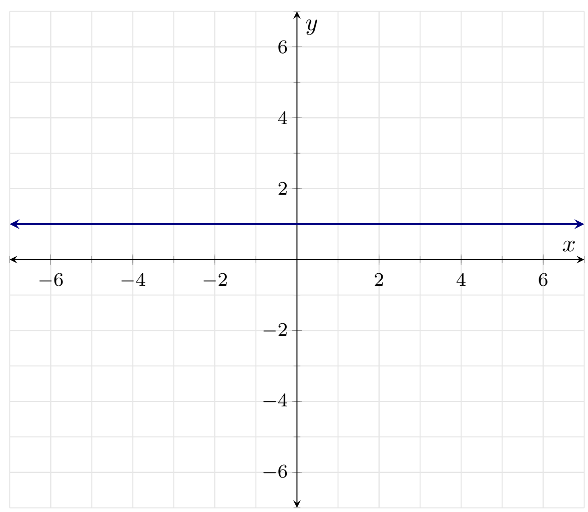
$f^{-1}(x) = \boxed{\dfrac{(x-3)^2+1}{5}}$

FP9.tex

Exercise 70 *In each part, you will be shown a graph of a function. Assume that all the important behavior of the functions is shown on the given graphs.*

(a) *The function corresponding to graph A below is*

Graph A



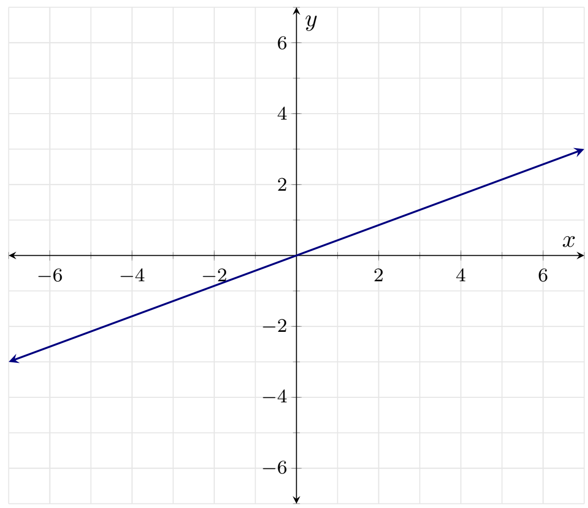
Multiple Choice:

(i) *one-to-one.*

(ii) *not one-to-one.* ✓

(b) *The function corresponding to graph B below is*

Graph B



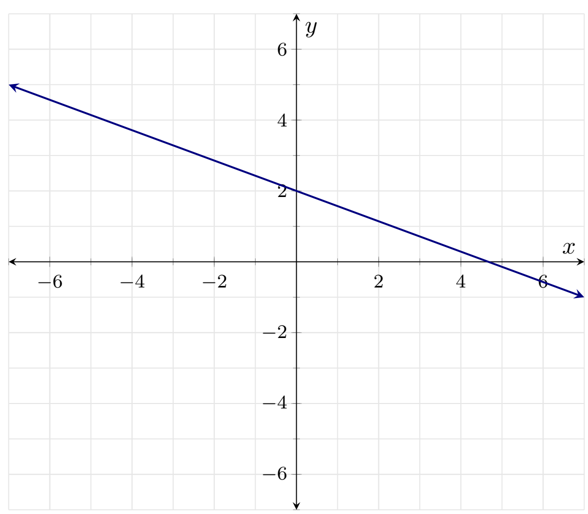
Multiple Choice:

(i) *one-to-one.* ✓

(ii) *not one-to-one.*

(c) *The function corresponding to graph C below is*

Graph C



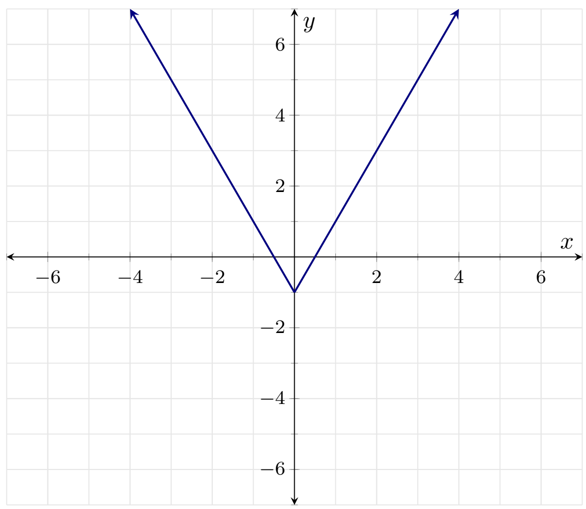
Multiple Choice:

(i) *one-to-one.* ✓

(ii) *not one-to-one.*

(d) *The function corresponding to graph D below is*

Graph D



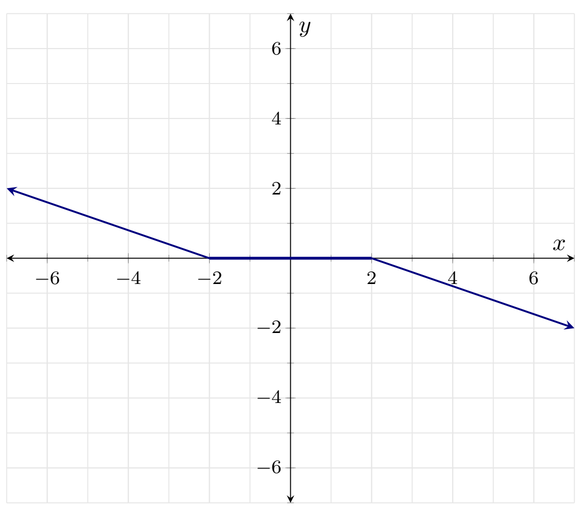
Multiple Choice:

(i) *one-to-one.*

(ii) *not one-to-one.* ✓

(e) *The function corresponding to graph E below is*

Graph E



Multiple Choice:

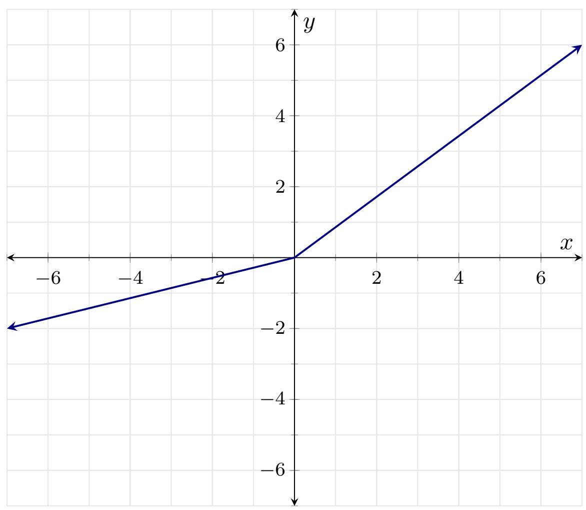
(i) *one-to-one.*

(ii) *not one-to-one.* ✓

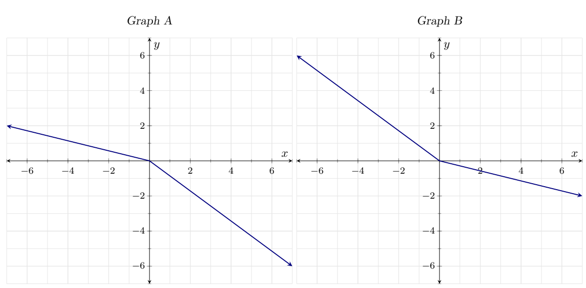
FP10.tex

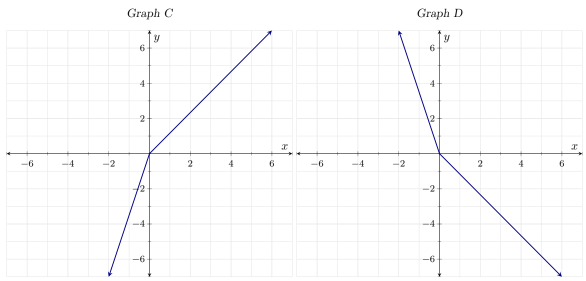
Exercise 71 *Look at the following graph of the one-to-one function f. Assume that all the important behavior of f is shown on the graph below.*

$y = f(x)$



Which of the following is the graph of f^{-1}? Assume that all the important behavior of the functions is shown on the graphs below.





Multiple Choice:

(a) *Graph A*

(b) *Graph B*

(c) *Graph C* ✓

(d) *Graph D*

Part 9

Average Rate of Change

`ARoC1.tex`

Exercise 72 *Melinda grows a unique type of mango known for its sweetness and smoothness. Because of this, the price of a mango increases with the distance from Melinda's farm. The function M gives the price of a mango in dollars given the distance x in miles from Melinda's farm:*

$$M(x) = \frac{1}{100}x^2 + 4$$

(a) *Compute $AV_{[1,10]}$.*

$AV_{[1,10]} = \$\boxed{1.11}$ *per mile from Melinda's farm.*

(b) *Compute $AV_{[200,300]}$.*

$AV_{[200,300]} = \$\boxed{5}$ *per mile from Melinda's farm.*

`ARoC2.tex`

Exercise 73 *The temperature T in degrees Fahrenheit t hours after 6 AM is given by:*

$$-\frac{1}{2}t^2 + 8t + 32,$$

for $0 \leq t \leq 12$.

(a) $T(4) = \boxed{56}^{\circ}$ *F. This is the temperature at*

Multiple Choice:

(i) *4AM.*
(ii) *10AM.* ✓
(iii) *4PM.*
(iv) *10PM.*

(b) *The average rate of change of T over the interval $[4, 8]$ is $\boxed{2}$.*

(c) *The average rate of change of T from $t = 8$ to $t = 12$ is $\boxed{-2}$.*

(d) *The average rate of temperature change between 10 AM and 6 PM is $\boxed{0}$.*

(e) *The units for the rates above are*

Multiple Choice:

(i) *degrees Fahrenheit.*

(ii) *degrees Celsius.*

(iii) *degrees Celsius per hour.*

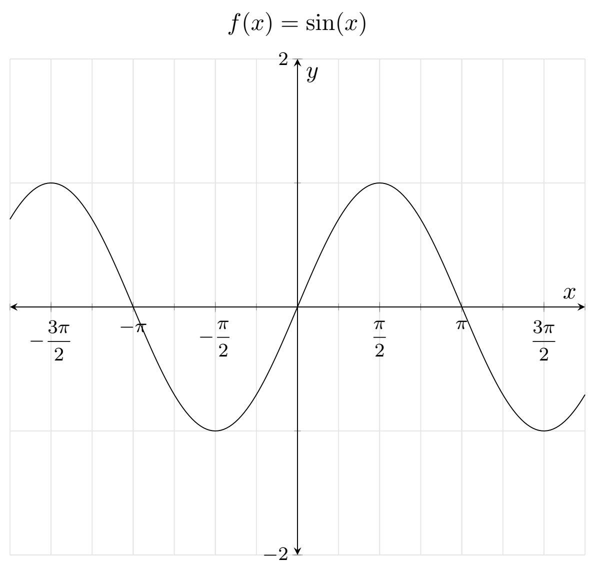
(iv) *degrees Celsius per minute.*

(v) *degrees Fahrenheit per hour.* ✓

(vi) *degrees Fahrenheit per minute.*

`ARoC3.tex`

Exercise 74 *Let* $f(x) = \sin(x)$*. The following information about the sine function may be helpful.*



Important Values of $f(x) = \sin(x)$	
x	$f(x)$
$-\pi$	0
$\frac{-\pi}{2}$	-1
0	0
$\frac{\pi}{2}$	1
π	0
$\frac{3\pi}{2}$	-1
2π	0

(a) *Compute* $AV_{[-\pi, \frac{3\pi}{2}]}$. *Give an exact answer.*

$AV_{[-\pi, \frac{3\pi}{2}]} = \boxed{-\frac{2}{5\pi}}$.

(b) *Based on your answer above, the sine function is*

Multiple Choice:

(i) *increasing on the interval* $\left[-\pi, \frac{3\pi}{2}\right]$.

(ii) *decreasing on the interval* $\left[-\pi, \frac{3\pi}{2}\right]$.

(iii) *constant on the interval* $\left[-\pi, \frac{3\pi}{2}\right]$.

(iv) *increasing on average on the interval* $\left[-\pi, \frac{3\pi}{2}\right]$.

(v) *decreasing on average on the interval* $\left[-\pi, \frac{3\pi}{2}\right]$. ✓

(vi) *constant on average on the interval* $\left[-\pi, \frac{3\pi}{2}\right]$.

(c) *Compute* $AV_{[0,2\pi]}$.

$AV_{[0,2\pi]} = \boxed{0}$.

(d) *Based on your answer above, the sine function is*

Multiple Choice:

(i) *increasing on the interval* $[0, 2\pi]$.

(ii) *decreasing on the interval* $[0, 2\pi]$.

(iii) *constant on the interval* $[0, 2\pi]$.

(iv) *increasing on average on the interval* $[0, 2\pi]$.

(v) *decreasing on average on the interval* $[0, 2\pi]$.

(vi) *constant on average on the interval* $[0, 2\pi]$. ✓

`ARoC4.tex`

Exercise 75 *The height of an object dropped from the roof of an eight story building is modeled by* $h(t) = -16t^2 + 64$, *where* $0 \leq t \leq 2$. *Here,* h *is the height of the object off the ground in feet,* t *seconds after the object is dropped.*

The slope of the line through the points $(0, h(0))$ *and* $(2, h(2))$ *is* $\boxed{-32}$.

`ARoC5.tex`

Exercise 76 *Using data from Bureau of Transportation Statistics, the average fuel economy* F *in miles per gallon for passenger cars in the US can be modeled by* $F(t) = -0.0076t^2 + 0.45t + 16$, *for* $0 \leq t \leq 28$, *where* t *is the number of years since 1980.*

(a) *Compute* $AV_{[0,28]}$.

$AV_{[0,28]} = \boxed{0.2372}$.

(b) *In this context,* $AV_{[0,28]}$ *represents*

Multiple Choice:

(i) *the average fuel economy for passenger cars in the US from 1980 to 2008.*

(ii) *the average price of fuel in the US from 1980 to 2008.*

(iii) *the average rate of change of the average fuel economy for passenger cars in the US from 1980 to 2008.* ✓

(c) *The units of* $AV_{[0,28]}$ *are*

Multiple Choice:

(i) *miles.*

(ii) *miles per gallon.*

(iii) *miles per gallon per year.* ✓

(iv) *miles per year.*

`ARoC6.tex`

Exercise 77 *Let* $f(x) = \dfrac{1}{x}$.

(a) *Compute* $AV_{[1,2]}$.

$AV_{[1,2]} = \boxed{-\dfrac{1}{2}}$.

(b) *Compute* $AV_{[100,101]}$.

$AV_{[100,101]} = \boxed{-\dfrac{1}{10100}}$.

`ARoC7.tex`

Exercise 78 *Let* $f(x) = x^3$.

(a) *Compute* $AV_{[3,5]}$.

$AV_{[3,5]} = \boxed{49}$.

Part 10

Polynomials

POLY1.tex

Exercise 79 *How many inches are in a mile?* $\boxed{63360}$ *inches* $= 1$ *mile*

Part 11

Rational Functions

RF1.tex

Exercise 80 *Select all expressions below which define rational functions:*

Multiple Choice:

(a) $\dfrac{x^4 - x + 1}{x^2 + 2x + 1}$ ✓

(b) $\dfrac{\sin(x^6 - 4x^3 + 7)}{x^8 - 10x^3 + 10x^2}$

(c) $\dfrac{x^{1000}}{x^{10} - x^9}$ ✓

(d) $x^7 - 34x^6 + 5x^2 + 10$ ✓

(e) $\cos\left(\dfrac{3x^5 + 4x^4 - 8x^3}{8x^9 - 45x^5 + 9x + 15}\right)$

(f) $\dfrac{4x + 5}{\sqrt{x^6 + 15}}$

RF2.tex

Exercise 81 *The rational function*

$$f(x) = \frac{x^6 + x^4 - 12x + 1}{x^2 - 7x + 6}$$

is defined for all real values of x*, except for (in increasing order)* $x = \boxed{1}$ *and* $x = \boxed{6}$.

RF3.tex

Exercise 82 *Rewrite the rational function*

$$f(x) = \frac{x^2 - 4}{x - 1} + \frac{x^2 - 3x}{x - 2}$$

in the form $f(x) = p(x)/q(x)$.

Answer: $f(x) = \dfrac{\boxed{2x^3 - x - 6x^2 + 8}}{\boxed{x^2 - 3x + 2}}$.

RF4.tex

Exercise 83 *The rational function*

$$f(x) = \frac{x^2 - 4x + 4}{(x-2)(x^2 - 7x + 12)}$$

is defined for all real values of x, except for (in increasing order) $x = \boxed{2}$, $x = \boxed{3}$, and $x = \boxed{4}$.

RF5.tex

Exercise 84 *Rewrite the rational function*

$$f(x) = \frac{x^3 + 4x}{x^2 + 2} - \frac{x + 3}{x^2 - 1}$$

in the form $f(x) = p(x)/q(x)$.

Answer: $f(x) = \dfrac{\boxed{x^5 + 2x^3 - 3x^2 - 6x - 6}}{\boxed{x^4 - x^2 + 2x^2 - 2}}$.

RF6.tex

Exercise 85 *Consider the rational function:*

$$f(x) = \frac{x^4 - 3x^3 + 10x + 1}{x^6 - 10x^5 + 5x^2 - 7}$$

Does it have any horizontal asymptotes?

Multiple Choice:

(a) *Yes* ✓

(b) *No*

Exercise 85.1 *The line equation is given by $y = \boxed{0}$.*

RF7.tex

Exercise 86 *Consider the rational function*

$$f(x) = \frac{x^2 - 12x + 35}{x^2 - 8x + 15}$$

(a) *The values c_1 and c_2 for which $f(x)$ is undefined are, in increasing order, $c_1 = \boxed{3}$ and $c_2 = \boxed{5}$.*

(b) *For the value c_1, we have a*

Multiple Choice:

(i) *Hole in the graph of $y = f(x)$.*

(ii) *Vertical asymptote of line equation $y = c_1$.* ✓

(c) *For the value c_2, we have a*

Multiple Choice:

(i) *Hole in the graph of $y = f(x)$.* ✓

(ii) *Vertical asymptote of line equation $y = c_2$.*

RF8.tex

Exercise 87 *Consider the rational function:*

$$f(x) = \frac{4x^5 + 100x^3 - 21x^2 + x}{3x^5 - 4x^3 + 12x^2 - 10}$$

Does it have any horizontal asymptotes?

Multiple Choice:

(a) *Yes* ✓

(b) *No*

Exercise 87.1 *The line equation is given by $y = \boxed{4/3}$.*

RF9.tex

Exercise 88 *Consider the rational function*

$$f(x) = \frac{(x^4+1)^3}{(x^2-13x+36)^2}$$

(a) *The values c_1 and c_2 for which $f(x)$ is undefined are, in increasing order, $c_1 = \boxed{4}$ and $c_2 = \boxed{9}$.*

(b) *For the value c_1, we have a*

Multiple Choice:

(i) *Hole in the graph of $y = f(x)$.*

(ii) *Vertical asymptote of line equation $y = c_1$.* ✓

(c) *For the value c_2, we have a*

Multiple Choice:

(i) *Hole in the graph of $y = f(x)$.*

(ii) *Vertical asymptote of line equation $y = c_2$.* ✓

`RF10.tex`

Exercise 89 *Consider the rational function:*

$$f(x) = \frac{6x^8 - 5x^5 + 6x^2 + 10}{10000x^5 - 10x^3 + 8x^2 + 99}$$

Does it have any horizontal asymptotes?

Multiple Choice:

(a) *Yes*

(b) *No* ✓

`RF11.tex`

Exercise 90 *Consider the rational function*

$$f(x) = \frac{(x-1)^2(x-2)^5(x-3)^3(x-4)^2}{(x-1)^3(x-2)^4(x-3)^3(x-4)^6}.$$

Select the correct options below, regarding the graph of $y = f(x)$.

Select All Correct Answers:

(a) *The line $x = 1$ is a vertical asymptote.* ✓

(b) *There is a hole in the graph with x-coordinate equal to 1.*

(c) *The line $x = 2$ is a vertical asymptote.*

(d) *There is a hole in the graph with x-coordinate equal to 2.* ✓

(e) *The line $x = 3$ is a vertical asymptote.*

(f) *There is a hole in the graph with x-coordinate equal to 3.* ✓

(g) *The line $x = 4$ is a vertical asymptote.* ✓

(h) *There is a hole in the graph with x-coordinate equal to 4.*

`RF12.tex`

Exercise 91 *Perform a long division to find the correct quotient and remainder:*

$$\frac{5x^4 - 3x^3 + 2x^2 - 1}{x^2 + 4} = \boxed{5x^2 - 3x - 18} + \frac{\boxed{12x + 71}}{x^2 + 4}$$

`RF13.tex`

Exercise 92 *Consider the rational function:*

$$f(x) = \frac{3x^6 - 6x^5 - 5x^2 + 2x - 15}{5x^4 + 6x^3 + 3x^2 - 6}.$$

Does it have a slant asymptote?

Multiple Choice:

(a) *Yes*

(b) *No* ✓

`RF14.tex`

Exercise 93 *Perform a long division to find the correct quotient and remainder:*

$$\frac{-x^5+7x^3-x}{x^3-x^2+1} = \boxed{-x^2-x+6} + \frac{\boxed{7x^2-6}}{x^3-x^2+1}$$

RF15.tex

Exercise 94 *Consider the rational function:*

$$f(x) = \frac{x^3-3x+1}{x^2+1}.$$

Does it have a slant asymptote?

Multiple Choice:

(a) *Yes* ✓

(b) *No*

Exercise 94.1 *The line equation is given by* $y = \boxed{x}$.

RF16.tex

Exercise 95 *Consider the rational function:*

$$f(x) = \frac{-5x^4-3x^3+x^2-10}{x^3-3x^2+3x-1}.$$

Does it have a slant asymptote?

Multiple Choice:

(a) *Yes* ✓

(b) *No*

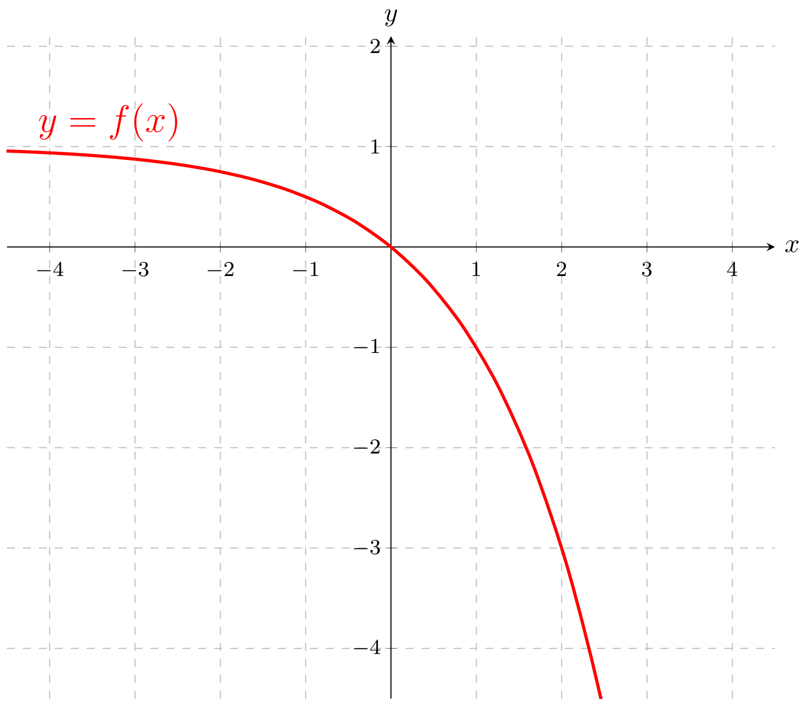
Exercise 95.1 *The line equation is given by* $y = \boxed{-5x-18}$.

Part 12

Domain

D1.tex

Exercise 96 *The following is the graph of an exponential function, $f(x)$.*



Which of the following could be a formula for $f(x)$?

Multiple Choice:

(a) $-2^x + 1$ ✓

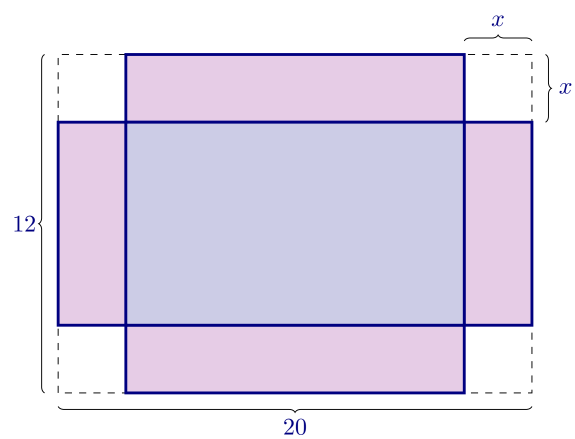
(b) $\left(\frac{1}{2}\right)^x - 1$

(c) $2^{-x} + 1$

(d) $\left(\frac{1}{2}\right)^{-x} - 1$

D2.tex

Exercise 97 *A box with an open top is to be constructed from a rectangular piece of cardboard with dimensions* 12 cm *by* 20 cm *by cutting out equal squares of side x at each corner and then folding up the sides:*



Express the volume V of the box as a function of x. (In factored form)

$$V(x) = \boxed{x(20-2x)(12-2x)}$$

Feedback(`attempt`): *When folded up, what is the width of the box in terms of x? The length? The height?*

Exercise 98 *Multiply out your answer above:*

$$V(x) = \boxed{4}x^3 + \boxed{-64}x^2 + \boxed{240}x$$

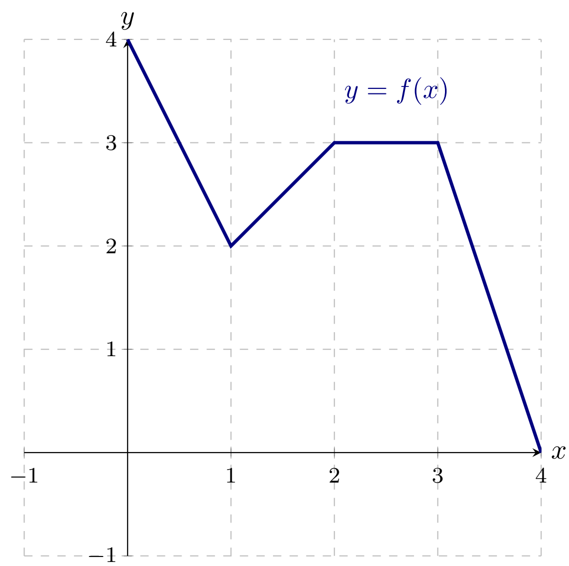
Exercise 99 *If x increases in value from 1 to $(1+h)$, by how much will volume of the box change? Simplify.*

$$V(1+h) - V(1) = \boxed{4}h^3 + \boxed{-52}h^2 + \boxed{124}h$$

Hint: *You found $V(x)$ above. Plug in $x = 1+h$ and $x = 1$, then subtract and simplify.*

`D3.tex`

Exercise 100 *Use the graph of $y = f(x)$ and the table for $g(x)$ below to find the requested function values.*



x	$g(x)$
0	0
1	3
2	3
3	0
4	4

$$(f+g)(1) = \boxed{5}$$

$$(g-f)(2) = \boxed{0}$$

$$\left(\frac{f}{g}\right)(4) = \boxed{0}$$

$$\left(\frac{g}{f}\right)(2) = \boxed{1}$$

D4.tex

Let $f(x) = \dfrac{2x^2 - 4x + 5}{2x^2 - x}$.

Exercise 101 *How many vertical asymptotes does f have?* $\boxed{2}$.

Exercise 101.1 *They are at: (List them in order from left to right)*

$$x = \boxed{0} \quad \text{and} \quad x = \boxed{\frac{1}{2}}$$

Exercise 102 *What is the end behavior of f?*

$$\text{As } x \to \infty, \quad f(x) \to \boxed{1}$$
$$\text{As } x \to -\infty, \quad f(x) \to \boxed{1}$$

Exercise 102.1 *Which of the following reasons justifies this? (Select all that apply)*

Select All Correct Answers:

(a) *The degree of the numerator is less than the degree of the denominator.*

(b) *The degree of the numerator equals the degree of the denominator.* ✓

(c) *The degree of the numerator is greater than the degree of the denominator.*

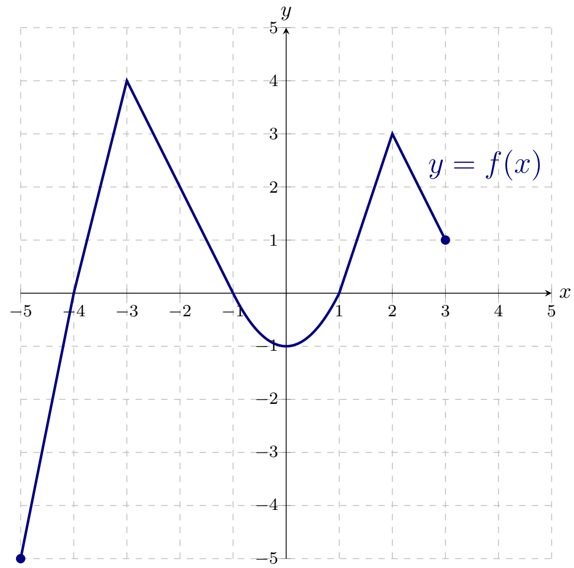
(d) *It is the ratio of the leading coefficients.* ✓

Exercise 103 *How many horizontal asymptotes does f have?* $\boxed{1}$.

Exercise 103.1 *It is at:* $y = \boxed{1}$.

`D5.tex`

The entire graph of a function f is given below. Use the graph of f to answer the questions.



Exercise 104

Find the domain of f.

$$[\boxed{-5}, \boxed{3}]$$

Exercise 105

Solve $f(x) = 4$.

$$x = \boxed{-3}$$

Exercise 106 *Solve $f(x) \geq 0$ using intervals written from left to right.*

$$[\boxed{-4}, \boxed{-1}] \cup [\boxed{1}, \boxed{3}]$$

D6.tex

Exercise 107 *The function f is defined by the formula* $f(x) = \frac{x-2}{3}$.

The domain of f is $(\boxed{-\infty}, \boxed{\infty})$.

Exercise 108 *The function g is defined by the formula* $g(x) = 5$.

The domain of g is $(\boxed{-\infty}, \boxed{\infty})$.

Exercise 109 *The function k is defined by the formula* $k(x) = 2x(x-4)$.

The domain of k is $(\boxed{-\infty}, \boxed{\infty})$.

D7.tex

Exercise 110 *The function f is defined by the formula* $f(x) = 2\sqrt{x+3}$.

The domain of f is $[\boxed{-3}, \boxed{\infty})$.

Exercise 111 *The function g is defined by the formula* $g(x) = \frac{2x}{x-1}$.

The domain of g is $(\boxed{-\infty}, \boxed{1}) \cup (\boxed{1}, \boxed{\infty})$.

Feedback(`attempt`): *Be sure to enter your intervals from left to right.*

Exercise 112 *The function k is defined by the formula* $k(x) = 2\sqrt{x+3} - \frac{2x}{x-1}$.

The domain of k is $[\boxed{-3}, \boxed{1}) \cup (\boxed{1}, \boxed{\infty})$.

Feedback(*`attempt`*): *Be sure to enter your intervals from left to right.*

`D8.tex`

Exercise 113 *The function f is defined by the formula $f(x) = \ln(5 - 2x)$.*

$$\text{The domain of } f \text{ is } \left(\boxed{-\infty}, \boxed{\frac{5}{2}}\right).$$

Exercise 114 *The function g is defined by the formula $g(x) = \sin(x)$.*

$$\text{The domain of } g \text{ is } \left(\boxed{-\infty}, \boxed{\infty}\right).$$

Exercise 115 *The function k is defined by the formula $k(x) = \sqrt[4]{3x + 1}$.*

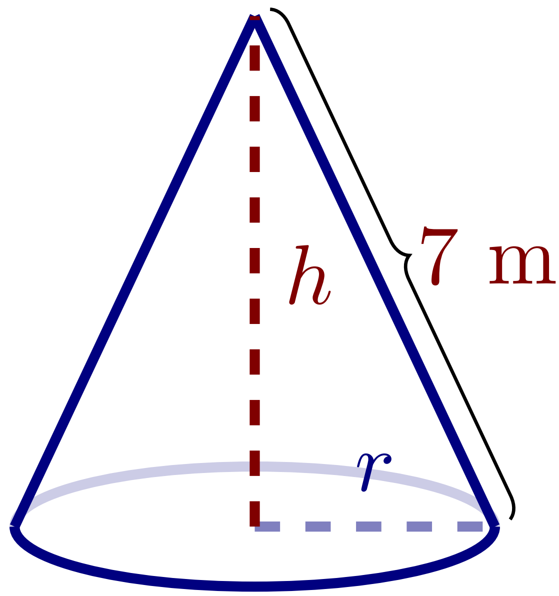
$$\text{The domain of } k \text{ is } \left[\boxed{-\frac{1}{3}}, \boxed{\infty}\right).$$

Exercise 116 *The function t is defined by the formula $t(x) = 2\ln(5 - 2x) + 6\sin(x) - \sqrt[4]{3x - 1}$.*

$$\text{The domain of } t \text{ is } \left[\boxed{-\frac{1}{3}}, \boxed{\frac{5}{2}}\right).$$

`D9.tex`

A right circular cone has a **fixed slant height** of 7 m. Call h the height of the cone and r the radius, as in the figure below.



Exercise 117 *h is a function of r. The formula for $h(r)$ is given by:*

$$h(r) = \boxed{\sqrt{49 - r^2}}$$

.

Hint: *Notice that h and r form the legs of a right triangle with the slant height of the cone as its hypotenuse. Think about the Pythagorean Theorem $a^2 + b^2 = c^2$.*

Exercise 117.1 *The domain of h is:* $\left[\boxed{-7}, \boxed{7}\right]$.

Hint: *You know that $49 - r^2$ can not be negative. Try plotting the parabola $y = 49 - x^2$ and seeing where the graph is above the x-axis.*

Part 13

Range

R1.tex

In each part, an invertible function f will be defined. For each function, find its inverse.

Exercise 118 $f(x) = 5x + 3$

$$f^{-1}(x) = \boxed{\frac{x-3}{5}}$$

Exercise 119 $f(x) = \dfrac{x-4}{7} - 2$

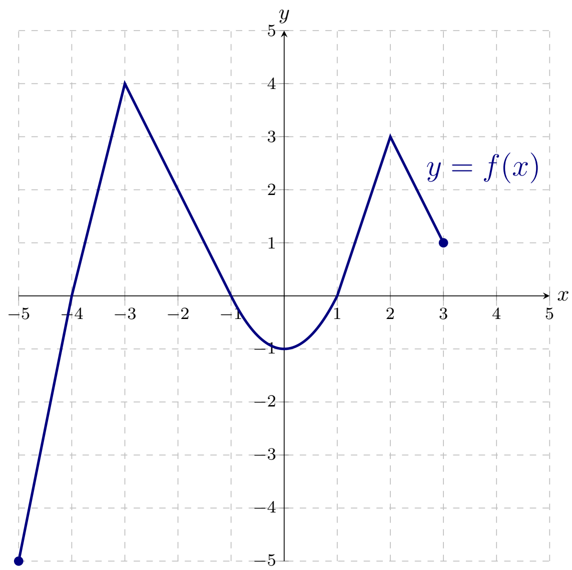
$$f^{-1}(x) = \boxed{7(x+2)+4}$$

Exercise 120 $f(x) = \sqrt[3]{3-x} + 1$

$$f^{-1}(x) = \boxed{3-(x-1)^3}$$

R2.tex

The entire graph of a function f is given below. Use the graph of f to answer the questions.



Exercise 121 *Find the range of f.*

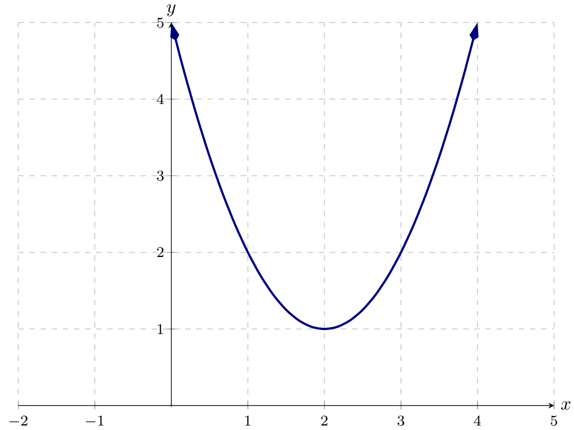
$$[\boxed{-5}, \boxed{4}]$$

Exercise 122 *List the x-values of the x-intercepts of f. (List your answers from least to greatest)*

$\boxed{-4}$, $\boxed{-1}$, *and* $\boxed{1}$

R3.tex

Exercise 123 *The function given by $f(x) = 3(x-2)^2 + 1$ (graphed below) is not a one-to-one function on $(-\infty, \infty)$. If we restrict the domain, however, it can be made to be one-to-one.*



Find a formula for $f^{-1}(x)$ when f is restricted to $(-\infty, 2]$.

$$f^{-1}(x) = \boxed{2 - \sqrt{\frac{x-1}{3}}}$$

Hint: *We're starting with $y = f(x)$, so that's:*

$$y = \boxed{3(x-2)^2 + 1}$$

Swap x and y.

$$x = \boxed{3(y-2)^2 + 1}$$

Solving for y you find two solutions. They are:

$$y = 2 - \sqrt{\boxed{\frac{x-1}{3}}}$$

$$y = 2 + \sqrt{\boxed{\frac{x-1}{3}}}$$

The domain of f was restricted to $(-\infty, 2]$, which means we want the range of f^{-1} to be $(-\infty, 2]$. Which of the two solutions you found give outputs which are not greater than 2?

R4.tex

The function f is invertible and takes the following values.

x	$f(x)$
0	5
1	2
2	4
3	1
4	3

Exercise 124 *Evaluate.*

$$f^{-1}(1) = \boxed{3}.$$

Exercise 125 *Solve the equation*

$$f^{-1}(x) = 2.$$

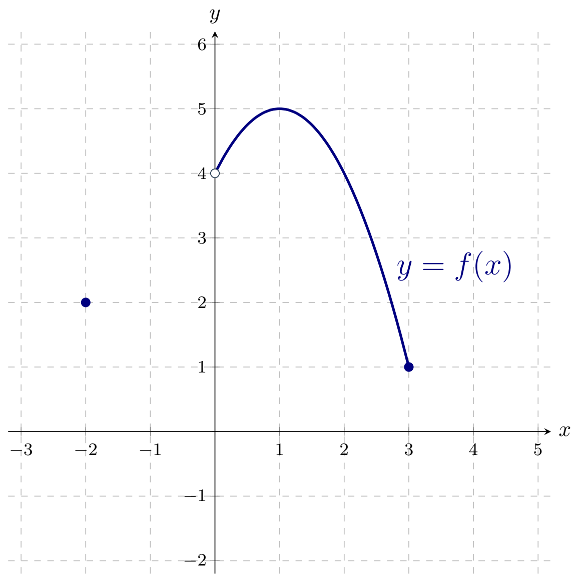
$$x = \boxed{4}$$

(If there is no answer, type DNE)

Hint: *What happens if we plug both sides of the equation $f^{-1}(x) = 2$ into the function f?*

`R5.tex`

The entire graph of a function f is given below. Use the graph of f to answer the questions.



Exercise 126 *Find the domain of f.*

$$\{\boxed{-2}\} \cup (\boxed{0}, \boxed{3}]$$

Exercise 127 *Find the range of f.*

$$[\boxed{1}, \boxed{5}]$$

Exercise 128 *Find the interval on which f is decreasing.*

$$[\boxed{1}, \boxed{3}]$$

`R6.tex`

Exercise 129 *The function f is defined by the formula $f(x) = 2x + 3$.*

The range of f is $(\boxed{-\infty}, \boxed{\infty})$.

Exercise 130 *The function g is defined by the formula $g(x) = 3x^2 + 5$.*

The range of g is $[\boxed{5}, \boxed{\infty})$.

Hint: *This is a quadratic, so it's graph is a parabola. Does it open upward or downward? Where is it's vertex?*

Exercise 131 *The function k is defined by the formula $k(x) = 2 + \ln(x)$.*

The range of k is $(\boxed{-\infty}, \boxed{\infty})$.

Hint: *Desmos link:* `https://www.desmos.com/calculator/na88gdkcto`

R7.tex

Exercise 132 *The function f is defined by the formula $f(x) = 3e^x + 1$.*

The range of f is $(\boxed{1}, \boxed{\infty})$.

Hint: *Desmos link:* `https://www.desmos.com/calculator/kcidkhjpkp`

Exercise 133 *The function g is defined by the formula $g(x) = 5\sin(x)$.*

The range of g is $[\boxed{-5}, \boxed{5}]$.

Exercise 133.1 *The function h is defined by the formula $h(x) = 5\sin(x^2)$.*

The range of h is $[\boxed{-5}, \boxed{5}]$.

Hint: *Desmos link:* `https://www.desmos.com/calculator/zpzx2bkz9u`

Exercise 133.1.1 *The function k is defined by the formula $k(x) = 5\sin(x^2 + e^x)$.*

The range of h is $[\boxed{-5}, \boxed{5}]$.

Hint: *Desmos link:* `https://www.desmos.com/calculator/qosps4wcaf`

R8.tex

Suppose an object is dropped from a height of 490 meters, and strikes the ground 10 seconds later. Let $h(t)$ denote the height of the object at time t, with h measured in meters, and t measured in seconds with $t = 0$ corresponding to the instant the object was released.

Exercise 134 *The domain of h is $[\boxed{0}, \boxed{10}]$.*

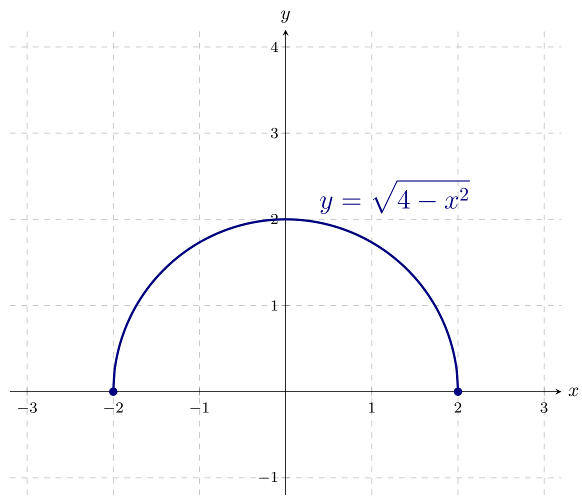
Exercise 134.1 *The range of h is $[\boxed{0}, \boxed{490}]$.*

Exercise 134.1.1 *The average rate of change of h between $t = 0$ and $t = 10$ is $\boxed{-49}$ m/s.*

R9.tex

If R is a positive constant, then the graph of $y = \sqrt{R^2 - x^2}$ is the top half of the circle of radius R centered at the origin.

As an example, this is graphed below for $R = 2$.



Exercise 135 *The domain of the function* $\sqrt{4 - x^2}$ *is* $[\boxed{-2}, \boxed{2}]$ *and the range is* $[\boxed{0}, \boxed{2}]$.

Hint: *This is exactly the function graphed above.*

Exercise 135.1 *The domain of the function* $\sqrt{25 - x^2}$ *is* $[\boxed{-5}, \boxed{5}]$ *and the range is* $[\boxed{0}, \boxed{5}]$.

Hint: *This is* $\sqrt{R^2 - x^2}$ *for* $R = 5$. *The graph of this function is a circle with what radius?*

Exercise 135.1.1 *The domain of the function* $\sqrt{R^2 - x^2}$ *is* $[\boxed{-R}, \boxed{R}]$ *and the range is* $[\boxed{0}, \boxed{R}]$.

Hint: *The graph of this function is a circle with what radius?*

Part 14

Composition of Functions

CoF3.tex

Exercise 136 *Suppose that $r = f(t)$ is the radius, in centimeters, of a circle at time t minutes, and $A(r)$ is the area, in square centimeters, of a circle of radius r centimeters.*

Which of the following statements best explains the meaning of the composite function $(A(f(t))$?

Multiple Choice:

(a) *The area of a circle, in square centimeters, of radius r centimeters.*

(b) *The area of a circle, in square centimeters, at time t minutes.* ✓

(c) *The radius of a circle, in centimeters, at timet minutes.*

(d) *The function f of the minutes and the area.*

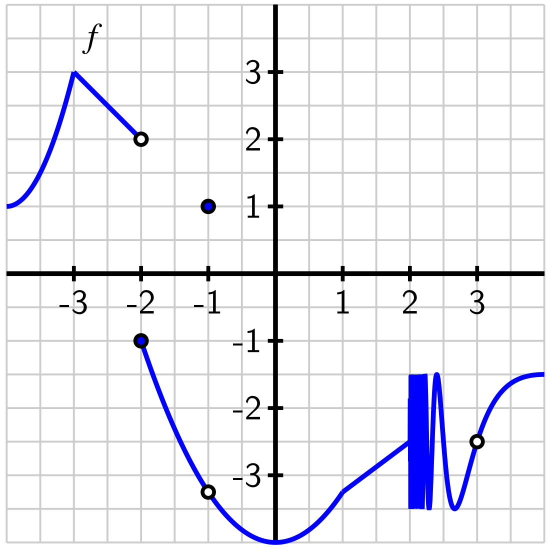
(e) *None of these choices.*

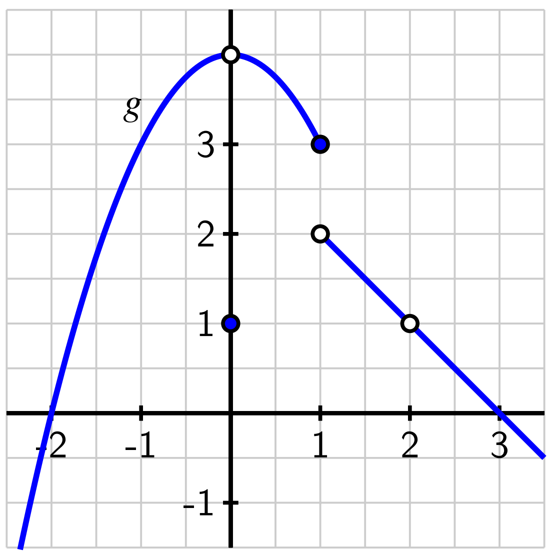
Suppose that $r = f(t) = t^3$. Recall that $A(r) = \pi r^2$. Find $A(f(t) = \boxed{\pi r^6}$.

CoF4.tex

Exercise 137 *Let functions f and g be given by the graphs below.*

An open circle means there is not a point at that location on the graph. For instance, $f(-1) = 1$, but $f(3)$ is not defined. If any answers below are not defined, write"undefined".





Determine:

- $f(f(-2)) = \boxed{1}$
- $f(g(1)) = \boxed{undefined}$
- $g(f(-2)) = \boxed{3}$

- $g(g(0)) = \boxed{3}$
- $g(f(-3)) = \boxed{0}$
- $f(g(2)) = \boxed{undefined}$

CoF5.tex

Let functions r and s be defined by the table below.

t	-4	-3	-2	-1	0	1	2	3	4
$r(t)$	4	1	2	3	0	-3	2	-1	-4
$s(t)$	-5	-6	-7	-8	0	8	7	6	5

Exercise 138 *Determine:*

- $(s \circ r)(3) = \boxed{-8}$
- $(s \circ r)(-4) = \boxed{5}$
- $(s \circ r)(0) = \boxed{0}$

Exercise 139 *Select all the values that are in the domain of r.*

Select All Correct Answers:

(a) -8

(b) -7

(c) -6

(d) -5

(e) -4 ✓

(f) -3 ✓

(g) -2 ✓

(h) -1 ✓

(i) 0 ✓

(j) 1 ✓

(k) 2 ✓

(l) 3 ✓

(m) 4 ✓

(n) 5

(o) 6

(p) 7

(q) 8

Exercise 140 *Select all the values that are in the domain of s.*

Select All Correct Answers:

(a) -8

(b) -7

(c) -6

(d) -5

(e) -4 ✓

(f) -3 ✓

(g) -2 ✓

(h) -1 ✓

(i) 0 ✓

(j) 1 ✓

(k) 2 ✓

(l) 3 ✓

(m) 4 ✓

(n) 5

(o) 6

(p) 7

(q) 8

Exercise 141 *Select all the values that are in the range of r.*

Select All Correct Answers:

(a) -8

(b) -7

(c) -6

(d) -5

(e) -4 ✓

(f) -3 ✓

(g) -2 ✓

(h) -1 ✓

(i) 0 ✓

(j) 1 ✓

(k) 2 ✓

(l) 3 ✓

(m) 4 ✓

(n) 5

(o) 6

(p) 7

(q) 8

Exercise 142 *Select all the values that are in the range of s.*

Select All Correct Answers:

(a) -8 ✓

(b) -7 ✓

(c) -6 ✓

(d) -5 ✓

(e) -4

(f) -3

(g) -2

(h) -1

(i) 0 ✓

(j) 1

(k) 2

(l) 3

(m) 4

(n) 5 ✓

(o) 6 ✓

(p) 7 ✓

(q) 8 ✓

Exercise 143 *Select all the values that are in the domain of* $s \circ r$.

Select All Correct Answers:

(a) -8

(b) -7

(c) -6

(d) -5

(e) -4 ✓

(f) -3 ✓

(g) -2 ✓

(h) -1 ✓

(i) 0 ✓

(j) 1 ✓

(k) 2 ✓

(l) 3 ✓

(m) 4 ✓

(n) 5

(o) 6

(p) 7

(q) 8

Exercise 144 *Select all the values that are in the domain of $r \circ s$.*

Select All Correct Answers:

(a) -8

(b) -7

(c) -6

(d) -5

(e) -4

(f) -3

(g) -2

(h) -1

(i) 0 ✓

(j) 1

(k) 2

(l) 3

(m) 4

(n) 5

(o) 6

(p) 7

(q) 8

CoF6.tex

Exercise 145 *For each of the following functions, find two simpler functions f and g such that the given function can be written as a composite function $g \circ f$. The functions f and g should each be a famous function or a polynomial.*

- *If* $g(f(x)) = \sin(x^2)$, *then we could decompose this function into* $g(x) = \boxed{\sin(x)}$ *and* $f(x) = \boxed{x^2}$.
- *If* $g(f(x)) = \sqrt{2x^5 - 7}$, *then we could decompose this function into* $g(x) = \boxed{\sqrt{x}}$ *and* $f(x) = \boxed{2x^5 - 7}$.
- *If* $g(f(x)) = e^{3x-x^2}$, *then we could decompose this function into* $g(x) = \boxed{e^x}$ *and* $f(x) = \boxed{3x - x^2}$.
- *If* $g(f(x)) = |\ln(x)|$, *then we could decompose this function into* $g(x) = \boxed{|x|}$ *and* $f(x) = \boxed{\ln(x)}$.
- *If* $g(f(x)) = 5e^{4x} + 7e^{3x} - 11e^x + 4$, *then we could decompose this function into* $g(x) = \boxed{5x^4 + 7x^3 - 11x + 4}$ *and* $f(x) = \boxed{e^x}$.

CoF7.tex

Use the given pair of functions to find the following values if they exist. If the value is not defined, write "undefined".

Exercise 146 $f(x) = x^2$, $g(x) = 2x + 1$

- $(g \circ f)(0) = \boxed{1}$
- $(f \circ g)(-1) = \boxed{1}$
- $(f \circ f)(2) = \boxed{16}$
- $(g \circ f)(-3) = \boxed{19}$
- $(f \circ g)\left(\frac{1}{2}\right) = \boxed{4}$

- $(f \circ f)(-2) = \boxed{16}$

Exercise 147 $f(x) = |x-1|$, $g(x) = x^2 - 5$

- $(g \circ f)(0) = \boxed{-4}$
- $(f \circ g)(-1) = \boxed{5}$
- $(f \circ f)(2) = \boxed{0}$
- $(g \circ f)(-3) = \boxed{11}$
- $(f \circ g)\left(\frac{1}{2}\right) = \boxed{\frac{23}{4}}$
- $(f \circ f)(-2) = \boxed{2}$

Exercise 148 $f(x) = \sqrt{3-x}$, $g(x) = x^2 + 1$

- $(g \circ f)(0) = \boxed{4}$
- $(f \circ g)(-1) = \boxed{1}$
- $(f \circ f)(2) = \boxed{\sqrt{2}}$
- $(g \circ f)(-3) = \boxed{7}$
- $(f \circ g)\left(\frac{1}{2}\right) = \boxed{\frac{\sqrt{7}}{2}}$
- $(f \circ f)(-2) = \boxed{\sqrt{3-\sqrt{5}}}$

Exercise 149 $f(x) = \sqrt[3]{x+1}$, $g(x) = 4x^2 - x$

- $(g \circ f)(0) = \boxed{3}$
- $(f \circ g)(-1) = \boxed{\sqrt[3]{6}}$

- $(f \circ f)(2) = \boxed{\sqrt[3]{\sqrt[3]{3}+1}}$
- $(g \circ f)(-3) = \boxed{4\sqrt[3]{4}+\sqrt[3]{2}}$
- $(f \circ g)\left(\frac{1}{2}\right) = \boxed{\frac{\sqrt[3]{12}}{2}}$
- $(f \circ f)(-2) = \boxed{0}$

Exercise 150 $f(x) = \dfrac{3}{1-x}$, $g(x) = \dfrac{4x}{x^2+1}$

- $(g \circ f)(0) = \boxed{\frac{6}{5}}$
- $(f \circ g)(-1) = \boxed{1}$
- $(f \circ f)(2) = \boxed{\frac{3}{4}}$
- $(g \circ f)(-3) = \boxed{\frac{48}{25}}$
- $(f \circ g)\left(\frac{1}{2}\right) = \boxed{-5}$
- $(f \circ f)(-2) = \boxed{undefined}$

`CoF8.tex`

Use the given pair of functions to find and simplify expressions for the following functions and state the domain of each using interval notation.

Exercise 151 *For* $f(x) = x^2 - x + 1$ *and* $g(x) = 3x - 5$

- $(g \circ f)(x) = \boxed{3x^2 - 3x - 2}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$
- $(f \circ g)(x) = \boxed{9x^2 - 33x + 31}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$
- $(f \circ f)(x) = \boxed{x^4 - 2x^3 + 2x^2 - x + 1}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$

Exercise 152 *For* $f(x) = x^2 - 4$ *and* $g(x) = |x|$

- $(g \circ f)(x) = \boxed{|x^2 - 4|}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$
- $(f \circ g)(x) = \boxed{x^2 - 4}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$
- $(f \circ f)(x) = \boxed{x^4 - 8x^2 + 12}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$

Exercise 153 *For* $f(x) = 3x - 5$ *and* $g(x) = \sqrt{x}$

- $(g \circ f)(x) = \boxed{\sqrt{3x - 5}}$ *with domain* $\left[\boxed{\frac{5}{3}}, \boxed{\infty}\right)$
- $(f \circ g)(x) = \boxed{3\sqrt{x} - 5}$ *with domain* $\left[\boxed{0}, \boxed{\infty}\right)$
- $(f \circ f)(x) = \boxed{9x - 20}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$

Exercise 154 *For* $f(x) = \dfrac{x}{2x + 1}$ *and* $g(x) = \dfrac{2x + 1}{x}$

- $(g \circ f)(x) = \boxed{\dfrac{4x + 1}{x}}$ *with domain* $\left(\boxed{-\infty}, \boxed{-\frac{1}{2}}\right) \cup \left(\boxed{-\frac{1}{2}}, \boxed{0}\right), \cup \left(\boxed{0}, \boxed{\infty}\right)$
- $(f \circ g)(x) = \boxed{\dfrac{2x + 1}{5x + 2}}$ *with domain* $\left(\boxed{-\infty}, \boxed{-\frac{2}{5}}\right) \cup \left(-\boxed{\frac{2}{5}}, \boxed{0}\right) \cup \left(\boxed{0}, \boxed{\infty}\right)$
- $(f \circ f)(x) = \boxed{\dfrac{x}{4x + 1}}$ *with domain* $\left(\boxed{-\infty}, \boxed{-\frac{1}{2}}\right) \cup \left(\boxed{-\frac{1}{2}}, \boxed{-\frac{1}{4}}\right) \cup \left(\boxed{-\frac{1}{4}}, \boxed{\infty}\right)$

Exercise 155 *For* $f(x) = |x|$ *and* $g(x) = \sqrt{4 - x}$

- $(g \circ f)(x) = \boxed{\sqrt{4 - |x|}}$ *with domain* $\left[\boxed{-4}, \boxed{4}\right]$

- $(f \circ g)(x) = \boxed{|\sqrt{4-x}|}$ *with domain* $\left(\boxed{-\infty}, \boxed{4}\right]$
- $(f \circ f)(x) = \boxed{|x|}$ *with domain* $\left(\boxed{-\infty}, \boxed{\infty}\right)$

CoF1.tex

Exercise 156 *Let* $f(x) = \dfrac{1}{x}$.

(a) *Compute* $AV_{[x,x+1]}$. *Assume* $[x, x+1]$ *is in the domain of* f. *Your answer will involve the variable* x.

$AV_{[x,x+1]} = \boxed{-\dfrac{1}{x^2+x}}$.

(b) *Compute* $AV_{[x,x+h]}$. *Assume* $[x, x+h]$ *is in the domain of* f. *Your answer will involve the variables* x *and* h.

$AV_{[x,x+h]} = \boxed{-\dfrac{1}{x^2+xh}}$.

CoF2.tex

Exercise 157 *Let* $f(x) = x^3$.

(a) *Compute* $AV_{[2,2+h]}$. *Your answer will involve the variable* h.

$AV_{[2,2+h]} = \boxed{12 + 6h + h^2}$.

(b) *Compute* $AV_{[x,x+2]}$. *Your answer will involve the variable* x.

$AV_{[x,x+2]} = \boxed{3x^2 + 6x + 4}$.

(c) *Compute* $AV_{[x,x+h]}$. *Your answer will involve the variables* x *and* h.

$AV_{[x,x+h]} = \boxed{3x^2 + 3xh + h^2}$.

Part 15

Zeros of Functions

ZoF1.tex

Exercise 158 *Feel free to use Desmos or another graphing calculator for the following problems.*

(a) *Let f be a function defined by $f(x) = 23$.*

The function f has $\boxed{0}$ *zero(s).*

(b) *Let g be a function defined by $g(x) = x^2 + 2x - 2$.*

The function g has $\boxed{2}$ *zero(s).*

(c) *Let h be a function defined by $h(x) = \dfrac{x^2 - 9}{x - 3}$.*

The function g has $\boxed{1}$ *zero(s).*

ZoF2.tex

Exercise 159 *For each function, select all zeros of the given function.*

(a) *Let f be a function defined by $f(x) = 3x - 5$. Select all zeros of f.*

Select All Correct Answers:

(i) $\frac{1}{3}$

(ii) $\frac{3}{5}$

(iii) 1

(iv) $\frac{5}{3}$ ✓

(b) *Let g be a function defined by $g(x) = 5 - x$. Select all zeros of g.*

Select All Correct Answers:

(i) 1

(ii) 4

(iii) 5 ✓

(iv) -5

(c) *Let h be a function defined by $h(x) = \dfrac{2 - x}{3}$. Select all zeros of h.*

Select All Correct Answers:

(i) $\frac{2}{3}$

(ii) $\frac{3}{2}$

(iii) 3

(iv) 2 ✓

`ZoF3.tex`

Exercise 160 *For each function, select all zeros of the given function. If there are none, do not select any options.*

(a) *Let f be a function defined by $f(x) = |x + 7|$. Select all zeros of f.*

Select All Correct Answers:

(i) 0

(ii) 7

(iii) -7 ✓

(iv) -14

(b) *Let g be a function defined by $g(x) = |x| - 7$. Select all zeros of g.*

Select All Correct Answers:

(i) 0

(ii) 7 ✓

(iii) -7 ✓

(iv) -14

(c) *Let h be a function defined by $h(x) = \frac{1}{4}|x - 6| - 3$. Select all zeros of h.*

Select All Correct Answers:

(i) -6 ✓

(ii) 0

(iii) 6

(iv) 12

(v) 18 ✓

(d) *Let j be a function defined by $j(x) = x - |x| + 22$. Select all zeros of j.*

Select All Correct Answers:

(i) -22
(ii) -11 ✓
(iii) 0
(iv) 11
(v) 22

ZoF4.tex

Exercise 161 *For each function, select all zeros of the given function. If there are none, do not select any options.*

(a) *Let f be a function defined by $f(x) = x^2 + 9$. Select all zeros of f.*

Select All Correct Answers:

(i) 3
(ii) -3
(iii) 0
(iv) 9

(b) *Let g be a function defined by $g(x) = -(x-5)^2$. Select all zeros of g.*

Select All Correct Answers:

(i) 0
(ii) -5
(iii) 5 ✓
(iv) 2

(c) *Let h be a function defined by $h(x) = x^2 - 3x - 4$. Select all zeros of h.*

Select All Correct Answers:

(i) -1 ✓
(ii) 0
(iii) 2
(iv) 3

(v) $\frac{4}{3}$

(vi) 4 ✓

(d) *Let j be a function defined by $j(x) = -4(x+3)^2 + 20$. Select all zeros of j.*

Select All Correct Answers:

(i) $-3-\sqrt{5}$ ✓

(ii) $3-\sqrt{5}$

(iii) $-3+\sqrt{5}$ ✓

(iv) $3+\sqrt{5}$

`ZoF5.tex`

Exercise 162 *The equation $12x - 3 = -5 - x$ can be rewritten as $f(x) = 0$ for some function f. In this case,*

$$f(x) = \boxed{13}\,x + 2.$$

The zero of f is $\boxed{-\frac{2}{13}}$.

`ZoF6.tex`

Exercise 163 *The equation $2x^2 - 3x - 2 = 5 - 3x$ can be rewritten as $f(x) = 0$ for some function f. In this case*

$$f(x) = \boxed{2}\,x^2 - 7.$$

Select the zeros of f below.

Select All Correct Answers:

(a) $\sqrt{\frac{7}{2}}$ ✓

(b) $-\sqrt{\frac{7}{2}}$ ✓

(c) $\sqrt{\frac{2}{7}}$

(d) 1.9

(e) 1.87

`ZoF7.tex`

Exercise 164 *In each part, select whether the term that best describes the prompt.*

(a) $27yz\sqrt{\ln(x)}$

Multiple Choice:

(i) *Expression* ✓

(ii) *Equation*

(b) $\sin(\cos(xy))$

Multiple Choice:

(i) *Expression* ✓

(ii) *Equation*

(c) $a^2 + b^2 = c^2$

Multiple Choice:

(i) *Expression*

(ii) *Equation* ✓

(d) $\cos(w) + 51e^x = 0$

Multiple Choice:

(i) *Expression*

(ii) *Equation* ✓

Part 16

Graphs and Relations

`ZOP1.tex`

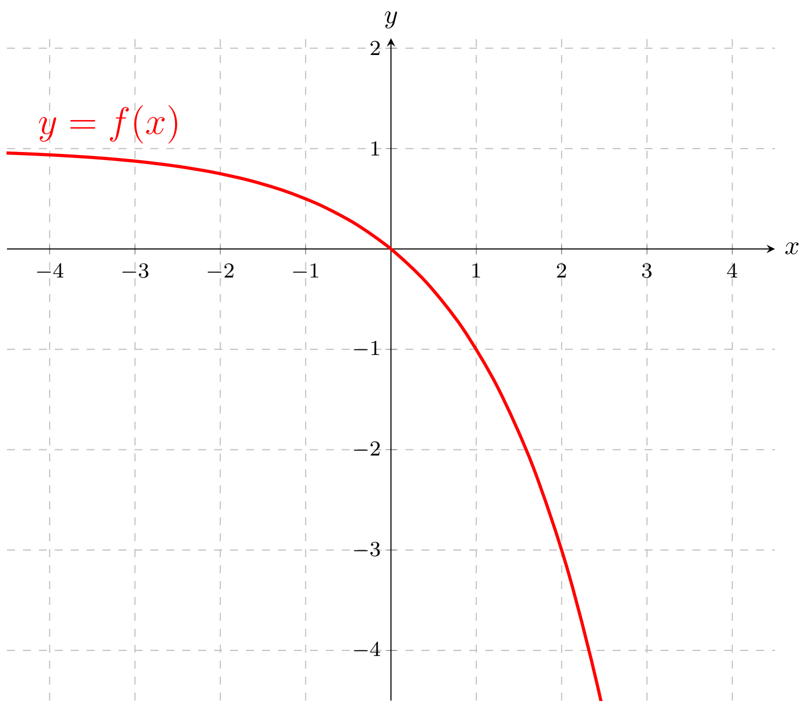
Exercise 165 *How many inches are in a mile?* $\boxed{63360}$ *inches* $= 1$ *mile*

Part 17

Zeros of Famous Functions

ZoFF1.tex

Exercise 166 *The following is the graph of an exponential function, $f(x)$.*



Which of the following could be a formula for $f(x)$?

Multiple Choice:

(a) $-2^x + 1$ ✓

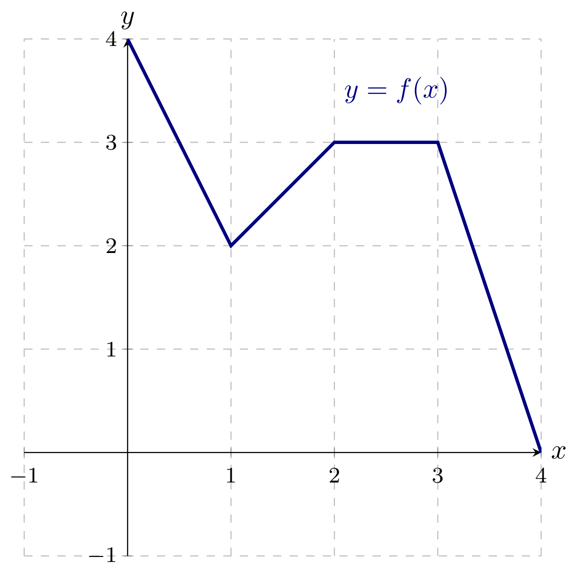
(b) $\left(\frac{1}{2}\right)^x - 1$

(c) $2^{-x} + 1$

(d) $\left(\frac{1}{2}\right)^{-x} - 1$

ZoFF2.tex

Exercise 167 *Use the graph of $y = f(x)$ and the table for $g(x)$ below to find the requested function values.*



x	$g(x)$
0	0
1	3
2	3
3	0
4	4

$$(f+g)(1) = \boxed{5}$$

$$(g-f)(2) = \boxed{0}$$

$$\left(\frac{f}{g}\right)(4) = \boxed{0}$$

$$\left(\frac{g}{f}\right)(2) = \boxed{1}$$

`ZoFF3.tex`

Let $f(x) = \dfrac{2x^2 - 4x + 5}{2x^2 - x}$.

Exercise 168 *How many vertical asymptotes does f have?* $\boxed{2}$.

Exercise 168.1 *They are at: (List them in order from left to right)*

$$x = \boxed{0} \quad \text{and} \quad x = \boxed{\frac{1}{2}}$$

Exercise 168.1.1 *The domain of f is: (List the intervals in order from left to right)*

$$\left(\boxed{-\infty}, \boxed{0}\right) \cup \left(\boxed{0}, \boxed{\frac{1}{2}}\right) \cup \left(\boxed{\frac{1}{2}}, \boxed{\infty}\right)$$

Exercise 169 *What is the end behavior of f?*

$$\text{As } x \to \infty, \quad f(x) \to \boxed{1}$$
$$\text{As } x \to -\infty, \quad f(x) \to \boxed{1}$$

Exercise 169.1 *Which of the following reasons justifies this? (Select all that apply)*

Select All Correct Answers:

(a) *The degree of the numerator is less than the degree of the denominator.*

(b) *The degree of the numerator equals the degree of the denominator.* ✓

(c) *The degree of the numerator is greater than the degree of the denominator.*

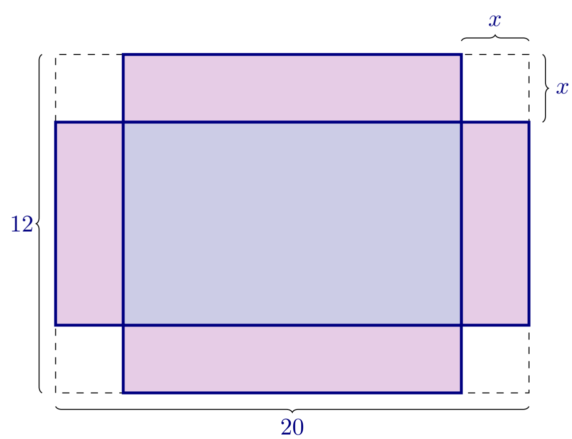
(d) *It is the ratio of the leading coefficients.* ✓

Exercise 169.1.1 *How many horizontal asymptotes does f have?* $\boxed{1}$.

Exercise 169.1.1.1 *It is at:* $y = \boxed{1}$.

ZoFF4.tex

Exercise 170 *A box with an open top is to be constructed from a rectangular piece of cardboard with dimensions* 12 cm *by* 20 cm *by cutting out equal squares of side x at each corner and then folding up the sides:*



Express the volume V of the box as a function of x. (In factored form)

$$V(x) = \boxed{x(20-2x)(12-2x)}$$

Feedback(*`attempt`*): *When folded up, what is the width of the box in terms of x? The length? The height?*

Exercise 170.1 *Multiply out your answer above:*

$$V(x) = \boxed{4}x^3 + \boxed{-64}x^2 + \boxed{240}x$$

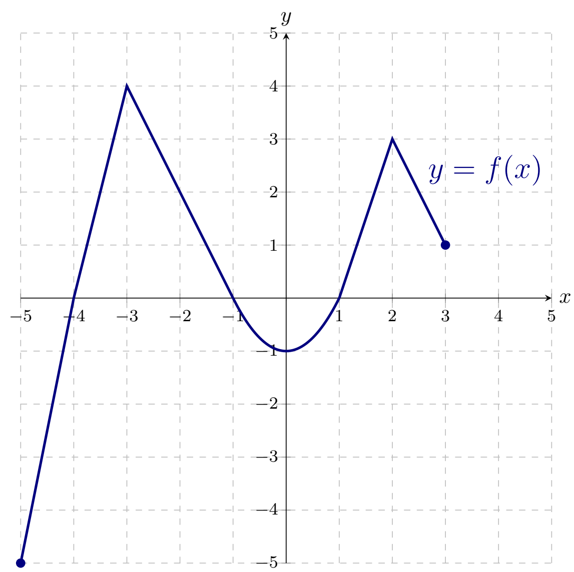
Exercise 170.1.1 *The domain of V is:*

$$\left[\boxed{0}, \boxed{6}\right]$$

Feedback(*`attempt`*): *Think about what x represents in the question. Can x be negative? Can the width or length of the box be negative?*

ZoFF5.tex

The entire graph of a function f is given below. Use the graph of f to answer the questions.



Exercise 171

Find the domain of f.

$$[\boxed{-5}, \boxed{3}]$$

Exercise 172

Solve $f(x) = 4$.

$$x = \boxed{-3}$$

Exercise 173 *Solve $f(x) \geq 0$ using intervals written from left to right.*

$$\left[\boxed{-4}, \boxed{-1}\right] \cup \left[\boxed{1}, \boxed{3}\right]$$

ZoFF6.tex

Exercise 174 *The function f is defined by the formula $f(x) = \dfrac{x-2}{3}$.*

The domain of f is $\left(\boxed{-\infty}, \boxed{\infty}\right)$.

Exercise 175 *The function g is defined by the formula $g(x) = 5$.*

The domain of g is $\left(\boxed{-\infty}, \boxed{\infty}\right)$.

Exercise 176 *The function k is defined by the formula $k(x) = 2x(x-4)$.*

The domain of k is $\left(\boxed{-\infty}, \boxed{\infty}\right)$.

ZoFF7.tex

Exercise 177 *The function f is defined by the formula $f(x) = 2\sqrt{x+3}$.*

The domain of f is $\left[\boxed{-3}, \boxed{\infty}\right)$.

Exercise 178 *The function g is defined by the formula $g(x) = \dfrac{2x}{x-1}$.*

The domain of g is $\left(\boxed{-\infty}, \boxed{1}\right) \cup \left(\boxed{1}, \boxed{\infty}\right)$.

Feedback(*`attempt`*): *Be sure to enter your intervals from left to right.*

Exercise 179 *The function k is defined by the formula $k(x) = 2\sqrt{x+3} - \dfrac{2x}{x-1}$.*

$$\text{The domain of } k \text{ is } [\boxed{-3}, \boxed{1}) \cup (\boxed{1}, \boxed{\infty}).$$

Feedback(*`attempt`*): *Be sure to enter your intervals from left to right.*

`ZoFF8.tex`

Exercise 180 *The function f is defined by the formula $f(x) = \ln(5 - 2x)$.*

$$\text{The domain of } f \text{ is } \left(\boxed{-\infty}, \boxed{\frac{5}{2}}\right).$$

Exercise 181 *The function g is defined by the formula $g(x) = \sin(x)$.*

$$\text{The domain of } g \text{ is } \left(\boxed{-\infty}, \boxed{\infty}\right).$$

Exercise 182 *The function k is defined by the formula $k(x) = \sqrt[4]{3x+1}$.*

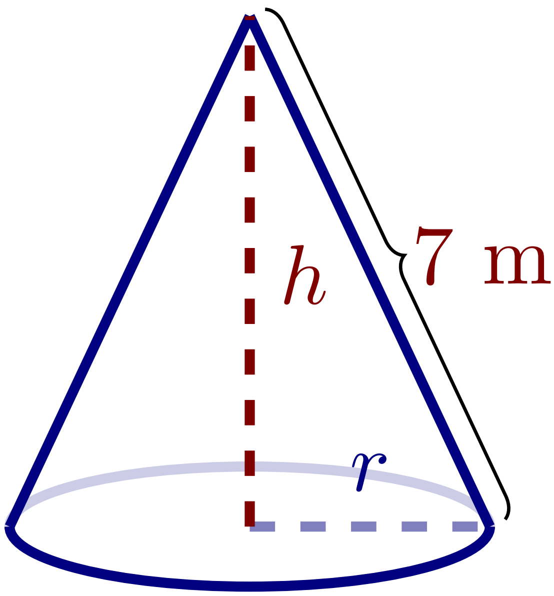
$$\text{The domain of } k \text{ is } \left[\boxed{-\frac{1}{3}}, \boxed{\infty}\right).$$

Exercise 183 *The function t is defined by the formula $t(x) = 2\ln(5-2x) + 6\sin(x) - \sqrt[4]{3x-1}$.*

$$\text{The domain of } t \text{ is } \left[\boxed{-\frac{1}{3}}, \boxed{\frac{5}{2}}\right).$$

`ZoFF9.tex`

A right circular cone has a **fixed slant height** of 7 m. Call h the height of the cone and r the radius, as in the figure below.



Exercise 184 *h is a function of r. The formula for $h(r)$ is given by:*

$$h(r) = \boxed{\sqrt{49 - r^2}}$$

.

Hint: *Notice that h and r form the legs of a right triangle with the slant height of the cone as its hypotenuse. Think about the Pythagorean Theorem $a^2 + b^2 = c^2$.*

Exercise 184.1 *The domain of h is:* $\left[\boxed{-7}, \boxed{7}\right]$.

Hint: *You know that $49 - r^2$ can not be negative. Try plotting the parabola $y = 49 - x^2$ and seeing where the graph is above the x-axis.*

Part 18

Linear Systems

SoE1.tex

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} x+2y &= 5 \\ x &= 6 \end{cases}$$

Exercise 185 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution* ✓

(b) *no solutions*

(c) *infinite solutions*

Exercise 185.1 *The solution to this system is* $\left(\boxed{6}, \boxed{-\frac{1}{2}}\right)$.

SoE2.tex

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} 2y-3x &= 1 \\ y &= -3 \end{cases}$$

Exercise 186 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution* ✓

(b) *no solutions*

(c) *infinite solutions*

Exercise 186.1 *The solution to this system is* $\left(\boxed{-\frac{7}{3}}, \boxed{-3}\right)$.

SoE3.tex

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} \dfrac{x+2y}{4} & = & -5 \\ \dfrac{3x-y}{2} & = & 1 \end{cases}$$

Exercise 187 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution* ✓

(b) *no solutions*

(c) *infinite solutions*

Exercise 187.1 *The solution to this system is* $\left(\boxed{-\frac{16}{7}}, \boxed{-\frac{62}{7}}\right)$.

SoE4.tex

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} \frac{2}{3}x - \frac{1}{5}y & = & 3 \\ \frac{1}{2}x + \frac{3}{4}y & = & 1 \end{cases}$$

Exercise 188 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution* ✓

(b) *no solutions*

(c) *infinite solutions*

Exercise 188.1 *The solution to this system is* $\left(\boxed{\frac{49}{12}}, \boxed{-\frac{25}{18}}\right)$.

`SoE5.tex`

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} \frac{1}{2}x - \frac{1}{3}y &= -1 \\ 2y - 3x &= 6 \end{cases}$$

Exercise 189 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution*

(b) *no solutions*

(c) *infinite solutions* ✓

`SoE6.tex`

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} x + 4y &= 6 \\ \frac{1}{12}x + \frac{1}{3}y &= \frac{1}{2} \end{cases}$$

Exercise 190 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution*

(b) *no solutions*

(c) *infinite solutions* ✓

SoE7.tex

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} 3y - \frac{3}{2}x & = & -\frac{15}{2} \\ \frac{1}{2}x - y & = & \frac{3}{2} \end{cases}$$

Exercise 191 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution*

(b) *no solutions* ✓

(c) *infinite solutions*

SoE8.tex

Solve the given system using substitution and/or elimination. Classify the system as having one solution, no solutions, or infinite solutions. Check your answer both algebraically and graphically.

$$\begin{cases} \frac{5}{6}x + \frac{5}{3}y & = & -\frac{7}{3} \\ \\ -\frac{10}{3}x - \frac{20}{3}y & = & 10 \end{cases}$$

Exercise 192 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution*

(b) *no solutions* ✓

(c) *infinite solutions*

SoE9.tex

Exercise 193 *A local buffet charges* \$7.50 *per person for the basic buffet and* \$9.25 *for the deluxe buffet (which includes crab legs.) If 27 diners went out to eat and the total bill was* \$227.00 *before taxes, how many chose the basic buffet and how many chose the deluxe buffet?*

Answer: $\boxed{13}$ *chose the basic buffet and* $\boxed{14}$ *chose the deluxe buffet.*

SoE10.tex

Exercise 194 *At The Old Home Fill'er Up and Keep on a-Truckin' Cafe, Mavis mixes two different types of coffee beans to produce a house blend. The first type costs \$3 per pound and the second costs \$8 per pound. How much of each type does Mavis use to make 50 pounds of a blend which costs \$6 per pound?*

Answer: Mavis needs $\boxed{20}$ *pounds of \$3 per pound coffee and* $\boxed{30}$ *pounds of \$8 per pound coffee.*

SoE11.tex

Exercise 195 *Skippy has a total of* \$*10,000 to split between two investments. One account offers* 3% *simple interest, and the other account offers* 8% *simple interest. For tax reasons, he can only earn* \$500 *in interest the entire year. How much money should Skippy invest in each account to earn* \$500 *in interest for the year?*

Answer: Skippy needs to invest \$$\boxed{6000}$ *in the* 3% *account and* \$$\boxed{4000}$ *in the* 8% *account.*

SoE12.tex

Exercise 196 *A 10% salt solution is to be mixed with pure water to produce 75 gallons of a 3% salt solution. How much of each are needed?*

Answer: $\boxed{22.5}$ *gallons of the 10% solution and* $\boxed{52.5}$ *gallons of pure water.*

SoE13.tex

Exercise 197 *At The Crispy Critter's Head Shop and Patchouli Emporium along with their dried up weeds, sunflower seeds and astrological postcards they sell an herbal tea blend. By weight, Type I herbal tea is 30% peppermint, 40% rose hips and 30% chamomile, Type II has percents 40%, 20% and 40%, respectively. How much of each Type of tea is needed to make a new blend of tea that is equal parts peppermint, rose hips and chamomile?*

Exercise 197.1 *First, assume you want to make 12 pounds of the new blend of tea. How much of each type would you need?*

Answer: $\boxed{8}$ *pounds of Type I,* $\boxed{4}$ *pounds of Type II.*

Exercise 197.1.1 *Now, assume you want to make 2 pounds of the new blend of tea. How much of each type would you need?*

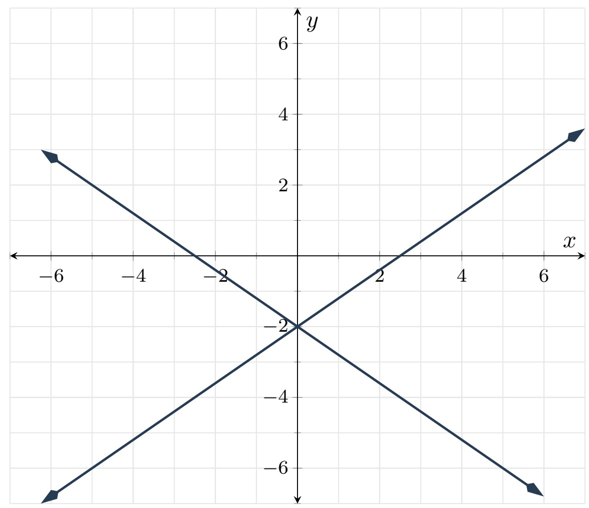
Answer: $\boxed{\frac{4}{3}}$ *pounds of Type I,* $\boxed{\frac{2}{3}}$ *pounds of Type II.*

Exercise 197.1.1.1 *Now, let t be the amount of the new tea you would like to make in pounds. How much of each type would you need? (Your answer will depend on t).*

Answer: $\boxed{\frac{2}{3}t}$ *pounds of Type I,* $\boxed{\frac{1}{3}t}$ *pounds of Type II.*

SoE14.tex

The following system of equations is given graphically. Determine if the system has one solution, no solutions, or infinite solutions.



Exercise 198 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution* ✓

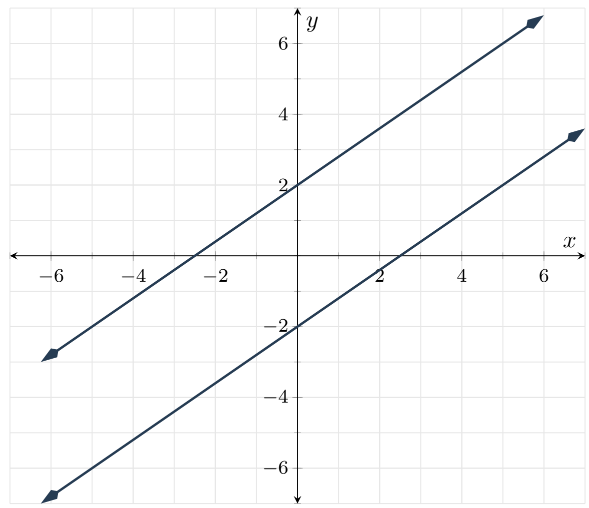
(b) *no solutions*

(c) *infinite solutions*

Exercise 198.1 *The solution to this system is* $\left(\boxed{0}, \boxed{-2}\right)$.

`SoE15.tex`

The following system of equations is given graphically. Determine if the system has one solution, no solutions, or infinite solutions.



Exercise 199 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

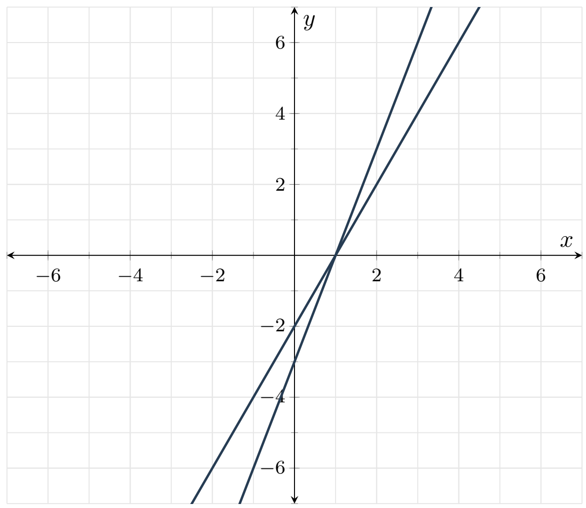
(a) *one solution*

(b) *no solutions* ✓

(c) *infinite solutions*

SoE16.tex

The following system of equations is given graphically. Determine if the system has one solution, no solutions, or infinite solutions.



Exercise 200 *Classify this system as having one solution, no solutions, or infinite solutions.*

Multiple Choice:

(a) *one solution* ✓

(b) *no solutions*

(c) *infinite solutions*

Exercise 200.1 *The solution to this system is* $\left(\boxed{1},\boxed{0}\right)$.

